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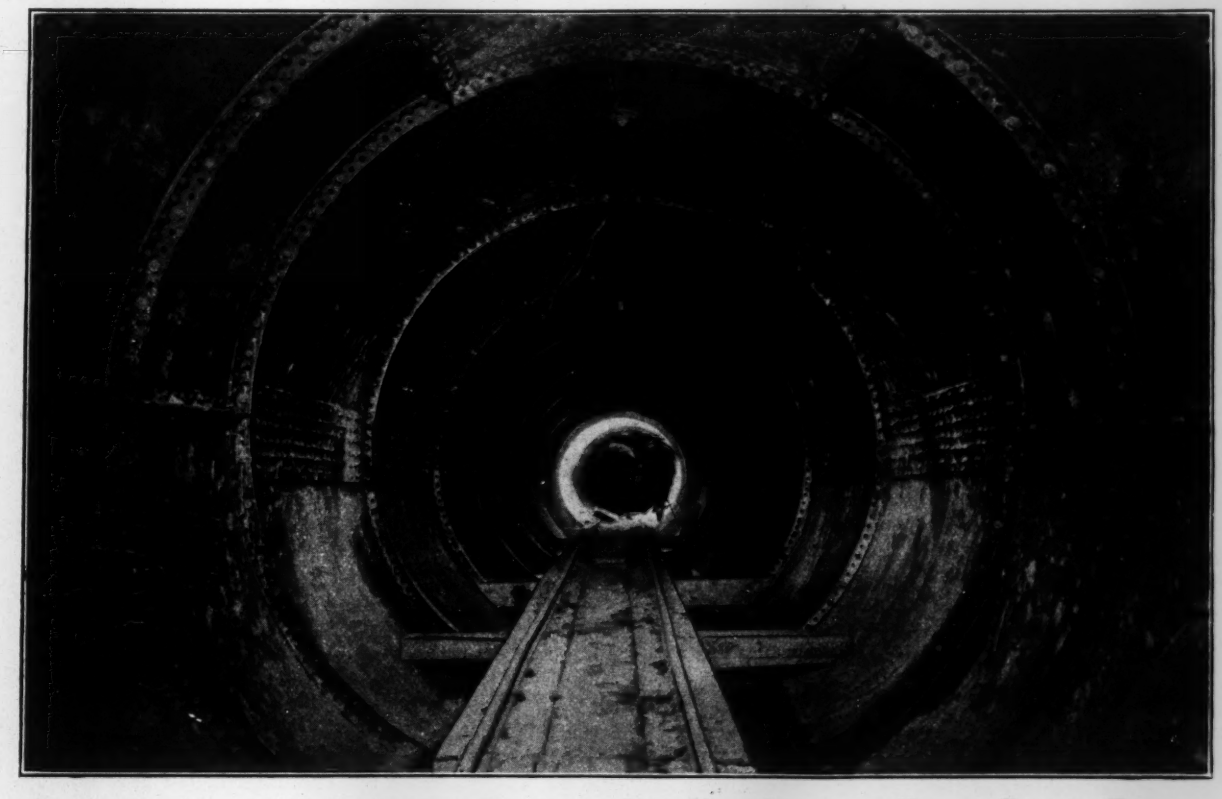
Making a Water-Tight Junction of a Large Steel Pipe and a Rock Tunnel under a High Head

By Arthur W. Tidd*

A number of valleys are crossed by the aqueduct for the new water-supply for New York City in the course of the 92 mi. from the Ashokan Reservoir in the Catskill Mountains to the Hill View Reservoir at the New York City line. One type of aqueduct for such crossings is a line of riveted steel pipe laid across the valley at the surface of the ground. At such crossings, the pipe line is laid directly down the slope to the bottom of the valley and up the opposite slope to the hydraulic gradient, connection at either end with the cut-and-cover type of aqueduct being made through a siphon chamber at grade. In one case, however, the steel pipe terminates near the bottom of the valley and joins a pressure tunnel (Fig. 1). It is the method of making a water-tight connection between the pipe and the tunnel at this point with the aqueduct in service under a head of about 168 ft., that this article describes. The steel pipe is the Bryn Mawr siphon and the tunnel the Yonkers Pressure tunnel. The location is about four miles north of the New York City line and about two miles east of the center of the City of Yonkers.

Design in Brief—The sectional plan at mid-height of the waterway and the vertical section on the center line of the aqueduct (Fig. 2) show the design in outline, which is, in effect, the continuation of the steel pipe of the siphon through the connection chamber and about 175 ft. into the tunnel, the pipe being completely embedded in the concrete lining of the tunnel. Four heavy special pipe castings and a 72-in. hydraulically operated gate valve are inserted in the line at the chamber. The steel lining of the tunnel, called the steel interlining, terminates in a steel diaphragm projecting outward all around at right angles to the axis of the tunnel. The interlining is designed to be absolutely tight against



Conical Portion of Steel Interlining, Junction of Bryn Mawr Siphon and Yonkers Pressure Tunnel, Catskill Aqueduct

(Looking from cylindrical portion toward the connection chamber. The sections are bolted in position ready for riveting.)

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leakage after erection and before embedding in concrete.

The enlarged longitudinal section (part of Fig. 2) shows the principal features inside the tunnel. The rough excavation is smoothed up by a concrete lining, the steel interlining erected, the 2-in. annular space grouted and the 8-in. concrete inner lining placed to form the waterway. The steel diaphragm projecting outward into a narrow groove in the rock marks the end of the steel interlining and the end of the special measures designed to effect a water-tight junction of the pipe and the tunnel. Beyond the diaphragm, the construction is of the ordinary concrete-lined tunnel type, the three branch tunnels joining at the bellmouth to form the standard tunnel of 16 ft. 7 in. finished diameter.

The tunnel is in rock, of the Yonkers gneiss formation, somewhat faulted at the portal, but not enough to require timbering, and sound at the bellmouth. The two side branch tunnels, constructed for the two additional pipes of the Bryn Mawr siphon to be built in the future, are similar in every way to the center tunnel, including the heavy castings and the gate valve.

Special Castings in the Connection Chamber—The 11-ft. 3-in. diameter, ½-in. butt-jointed, steel pipe of the Bryn Mawr siphon draws down by means of a special reducing section, about 13 ft. long, to a diameter of 8 ft. 10⅛ in., terminating in a calking ring of ¾-in. plate, 9 in. wide, riveted with countersunk rivets on the outside of the ½-in. shell of the pipe (see Fig. 3). The calking ring enters the socket of the first of the special castings, the reducing wall pipe. This socket is of unusual depth (24 in.), to enable the lead joint to be calked on the inside (see Fig. 4). The next casting is the expansion piece, of ordinary design, followed by a 72-in hydraulically-operated gate valve. Next to the valve is the manhole pipe, the manhole, 36 in. in diameter, giving the only access to the tunnel other than through the uptake shaft at Hill View Reservoir, when the gate valve is closed. The increasing wall pipe, the last of the line, follows. This casting has a socket end for the manhole pipe and a flange end for the connection with the steel interlining of the tunnel which immediately follows.

The average weight of the various pieces is as follows:

	Lb.
Reducing wall pipe	34,500
Expansion piece	4,000
72-in. gate valve	46,000
Hydraulic cylinder	20,000
Manhole pipe	14,700
Increasing wall pipe	8,300

No especial difficulties were encountered in the handling and assembling of the valve or castings other than those incident to the moving and precise placing of any castings of such weight and size. The reducing wall pipe was set first and concreted into the base of the chamber. The increasing wall pipe was next bolted to the steel interlining, which was already in place and concreted, and concreted into the base of the chamber. The manhole pipe and the expansion piece were next placed, leaving a gap to be closed by the valve. The valve was then slid into position and the bolted joint on either side made up, using lead gaskets. For the bolted joint between the increasing wall pipe and the steel interlining, a special soft-lead gasket, $\frac{9}{32}$ in. thick, 2½ in. wide, punched for the bolts, was designed to take care of the unevenness in the end angle of the steel interlining (see Fig. 5). Also, since the angle was turned inward, grummets of ⅛ in. soft copper wire were used under the bolt heads to prevent leakage along the bolts. The joint between the reducing pipe and the expansion piece was poured, but with unsatisfactory results. A similar joint on one of the side lines was also poured, but with equally unsatisfactory results. Both side- and top-pouring-hole methods were used, and both joints had to be melted out and repoured, but finally an acceptable result was obtained. The rest of the joints were made with lead wool, calked with pneumatic calkers operated by compressed air under about 60 lb. pressure. The gasket for the joint at the manhole cover was a copper ring, H-shape in section and about $\frac{3}{16}$ in. thick. The largest lead joint (diameter 9 ft. 2⅝ in.) was unusual on account of its size and also on account of its depth, about 8 in. Special calking tools were required to be made for this joint, and about 1200 lb. of lead wool were used. About 450 lb. were driven into the smallest joint.

Fifty-six 1⅝-in. steel bolts were used on each flange of the 72-in. gate valve; thirty-two 1⅛-in. steel bolts with bronze nuts were used on the manhole cover and ninety-two ⅞-in. steel bolts were used to connect the increasing wall pipe to the end angle of the steel interlining.

The lead joint on the manhole pipe and on the expansion piece were made solid against longitudinal movement by driving many wrought-iron wedges between the spigot end and the base of the socket on the inside of the pipe.

Outer Concrete Lining of Tunnel—The first operation in the tunnel after excavation was the placing of the outer concrete lining of 5 in. minimum thickness to the rock and 11 ft. 8 in. inside diameter for the 140 ft. between the end of the conical portion of the steel interlining and the steel diaphragm, both to be described later. The cross-section was circular. The invert was first laid, 5 ft. in width, screeded and finished, using side planks set radially for forms. The "Jackson" forms were then set up for placing the rest of the section. The Jackson forms consisted of full-circle ribs of the diameter of the tunnel, made up of 5-in. I-beams with a 5-in. I-beam post in the center and two 5-in. channels riveted together back to back, set across the horizontal diameter. Bolted joints permitted the form to be dismantled, taken through the forms in use and reassembled for the next stretch. The forms were set at 3-ft. intervals. For the lagging, ⅛-in. steel plates 12 in. wide by 36 in. long, curved to the radius of the tunnel and stiffened by 1½x 1½-in. angles, were used. The lagging was placed as the concrete rose.

A small amount of water from a general seepage and a few leaking seams was encountered, but gave no difficulty in handling. In several instances pockets of crushed stone, 1 to 2 cu.ft. in volume, were placed against the seams as the concrete was being placed. Holes were subsequently drilled through into these pockets, providing access to the seams for grouting. Portland cement concrete, proportioned 1 to 6, was used.

Steel Interlining—The steel interlining (see details, Fig. 6), starting at the increasing wall pipe with a diameter of 8 ft. 3 in., increased in a distance of about 35 ft. to a diameter of 11 ft. 4 in. and continued with that diameter to the terminal steel diaphragm, a distance of about 140 ft. The first or conical portion was made of $\frac{7}{16}$-in. plate, butt-jointed, full-circle sections about 6 ft. long, all joints shop calked wherever possible. The remainder or cylindrical portion was made of $\frac{5}{16}$-in. plate

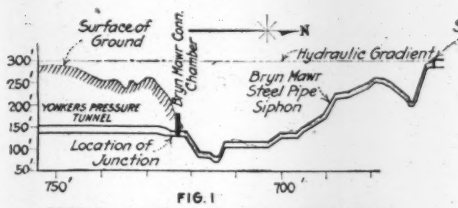
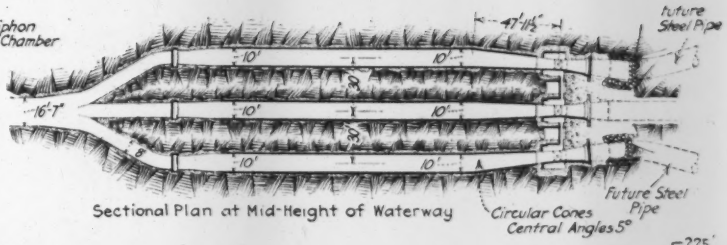
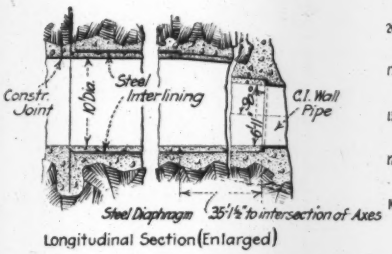


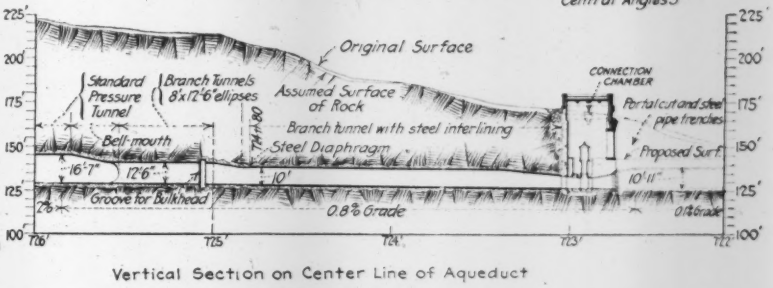
FIG. 1
PROFILE OF AQUEDUCT AT CONNECTION CHAMBER



Sectional Plan at Mid-Height of Waterway



Longitudinal Section (Enlarged)



Vertical Section on Center Line of Aqueduct

FIG. 2 - DETAILS OF BRANCH TUNNELS AND CONNECTION CHAMBER

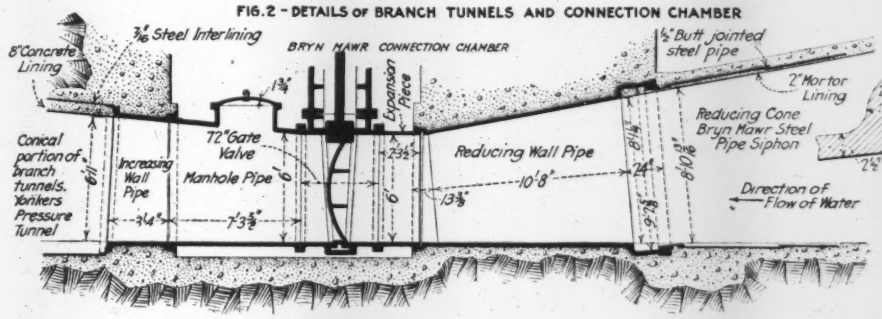

⅜" Steel Interlining
BRYN MAWR CONNECTION CHAMBER
8" Concrete Lining
½" Butt jointed steel pipe
2" Mortor Lining
Reducing Cone Bryn Mawr Steel Pipe Siphon
Conical portion of branch tunnels, Yonkers Pressure Tunnel
Increasing Wall Pipe
72" Gate Valve
Manhole Pipe
Reducing Wall Pipe
Direction of Flow of Water

FIG. 3 - LONGITUDINAL SECTION THROUGH SPECIAL PIPE CASTINGS AT CONNECTION CHAMBER

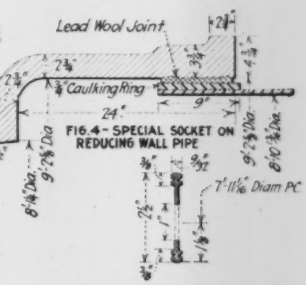


FIG. 4 - SPECIAL SOCKET ON REDUCING WALL PIPE

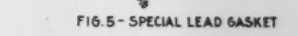
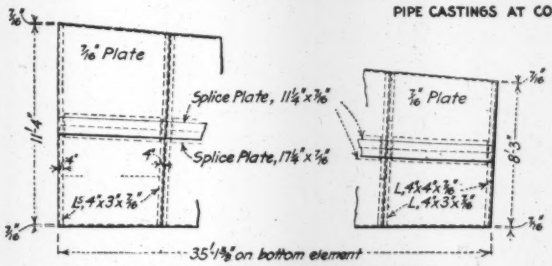
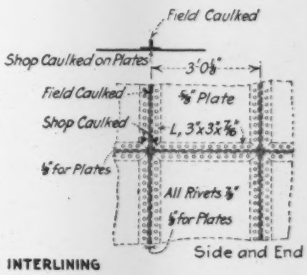


FIG. 5 - SPECIAL LEAD GASKET
(Section through Bolt Hole)



Side Elevation of Conical Portion of Steel Interlining



Side and End View of Cylindrical Portion of Steel Interlining

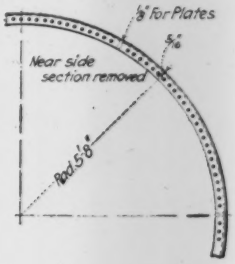
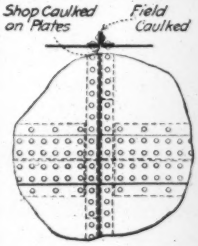


FIG. 6 - DETAILS OF STEEL INTERLINING



Joint of Conical Portion (Enlarged)

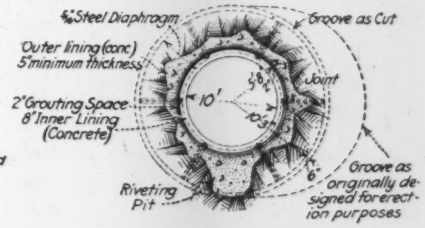


FIG. 7 - STEEL DIAPHRAGM

FIGS 1 TO 7. JUNCTION BETWEEN BRYN MAWR STEEL SIPHON AND YONKERS PRESSURE TUNNEL, CATSKILL AQUEDUCT

and in segments, as described later. All had inward-turned angles for connecting and riveting the sections in the tunnel.

The first operation in the conical portion of the tunnel was the placing of a strip of the invert of the concrete outer lining from a point near the south wall of the connection chamber to the already completed concrete of the cylindrical portion. The invert was laid and screeded to a radius 2 in. larger than the steel. Across the invert were laid short lengths, about 5 ft. for the largest radius, of 6-in. 8-lb. steel channels with flanges (2 in. in width) upturned, bent to the radius of the steel interlining,

on which supports the sections of the interlining were erected. Beginning at the intersection of the cone and cylinder, one section of the cylindrical portion of the interlining having been first carefully placed and trued up in order to make a correct start, the first of the 6-ft. lengths of the cone was erected and the entire surrounding space between the steel and the rock filled with concrete. The 2-in. space beneath the steel on the invert was filled by pouring in thick grout and churning it thoroughly to insure complete filling. For the sides and arch, the concrete was placed by the usual methods, especial care being taken to compact it thoroughly and to make a tight contact with the steel. The procedure was similar for each of the remaining sections of the cone, the section at the portal of the tunnel being the last to be placed and concreted. A grout pipe, to be described later, was placed in the top of each section extending to the rock.

The cylindrical portion of the steel interlining consisted of sections 3 ft. in length, each section being composed of six segments which, when riveted together, formed a circle of diameter 11 ft. 4 in. Each segment was of $\frac{5}{16}$-in. plate, curved to the radius of 5 ft. 8 in., with a 3x3x$\frac{7}{16}$-in. angle riveted to each of the four edges of the plate. The angles were mitered on the corners and projected $\frac{1}{16}$ in. beyond the edge of the plate all around. All joints were shop calked where possible, a fundamental principle in the design, construction and inspection being to make the interlining in itself tight against leakage. In erecting the sections, 5-ft. lengths of 6-in. 8-lb. curved channels were laid across the invert, as described for the conical portion. These formed the 2-in. grout space on the bottom, a feature of this portion of the design being an annular space 2 in. wide between the steel interlining and the outer concrete lining of the tunnel, filled with grout after the steel was erected and calked. The segments were erected without difficulty. All joints throughout the entire length of the interlining were riveted with the exception of the one at the increasing wall pipe. Pneumatic tools were used for all the riveting and practically all the calking. Soft steel wedges were driven into the openings at corners, etc., and calked. The thorough character of the work was proved by the very small amount of leakage when the 2-in. annular space was grouted.

STEEL DIAPHRAGM—At the termination of the steel interlining, a circular steel diaphragm or water stop was erected (Figs. 7 and 8), projecting about 4 ft. 6 in. beyond the interlining and at right angles thereto into a narrow groove cut in the rock. The diaphragm was riveted and calked to the steel interlining and grouted into the groove at the same time that the 2-in. annular space around the interlining was grouted.

The cutting of the groove proved to be very slow and expensive. The specification in the contract covering this work was as follows:

Sect. 17.2. The channels to be constructed under this item shall be of such depth as to permit the erection of a diaphragm which, in general, projects 3 ft. and in no case less than 2 ft. beyond the actual excavation. The dimensions of the diaphragm shown on drawing will be increased and the channels shall be correspondingly deepened if necessary to fulfill this condition. The channels shall be not less than 1½ in., nor more than 4 in. in width at any place, unless otherwise expressly permitted. They shall be truly normal to the axis of the tunnel, and shall be so accurately cut that they will permit the convenient erection of the diaphragm. These channels shall be cut with a channeling machine, or by drilling and broaching, and care shall be taken to avoid any shattering of the surrounding rock. They shall be completely cleaned of all débris and shall be kept clean until refilled, in accordance with orders. These channels shall be cut at such times that the erection of the steel interlining and the completion of all other work in the branch tunnels shall not be delayed.

The method to be used was the subject of much discussion. The cutting was finally done with ordinary rock drills mounted on columns, so as to permit radial cutting, the operation being that of cutting away the entire rock as with channeling machines. No other method was tried. The groove was started with a 3½-in. bit and somewhat smaller bits were used as the channel deepened. Two drills were usually used on one column. One of the greatest difficulties encountered was in guiding the drill so as to cut in a plane. Guides made of steel angles between which the drill could run, placed close to the rock, were tried but given up. The method finally adopted was to use the end of the steel interlining in its finally erected position as a guide, holding the shank of the drill against it while drilling. The hardness and texture of the rock varied, oftentimes within the space of a few inches, and occasional seams were encountered. Both these operated to throw the drill to one side and deflect the channel from its true plane. When this occurred, the only way to get the groove back onto line was to drill small shallow holes as nearly parallel to the plane of the groove as possible, shoot off the projecting rock with light charges, and make a fresh start with the drill. In spite of all the pains taken, difficulties were encountered from this source when rotating the diaphragm during erection. The average depth of cut was about 4 ft. for the groove in the east branch tunnel, 3 ft. in the center tunnel and 2.5 ft. in the west tunnel, the maximum cut being 4.5 ft. and the average area of groove cut (area of plane normal to axis of tunnel) 159.1 sq.ft. The average time per groove required for cutting was equivalent to 101 eight-hour shifts for one driller and one helper.

The steel diaphragm was $\frac{5}{16}$ in. thick, 20 ft. 6 in. in diameter, and composed of six segments with field-riveted joints. The original design contemplated cutting the groove on one side of the tunnel to a sufficient additional depth, 4 ft. at the maximum, to permit the diaphragm to be rotated and shifted as each segment was attached and the radial joint riveted, until the full circle was completed, whereupon the diaphragm would be shifted back, brought into position and riveted to the interlining. It was apparent very soon after drilling commenced that it would be extremely difficult to cut the groove to such a depth and modifications of the method were studied, with the result that the contractor was permitted to excavate a riveting pit in the invert about 3 ft. square and 4 ft. deep. In this pit, each joint was exposed for riveting by rotating the diaphragm on the end of the interlining. Even with this modification, some trouble was experienced as the diaphragm was rotated, due to irregularities and projections in the groove.

GROUTING THE 2-IN. ANNULAR SPACE—The next step was to complete the lining of the tunnel up to and against the south side of the diaphragm, but not filling the groove. To prevent the entrance of concrete into the groove during concreting, the opening on each side of the tunnel from the invert well up to the crown was closed with brickwork about 8 in. square, laid against the diaphragm and following the irregularities of the rock. The portion of the riveting pit and the diaphragm groove be-

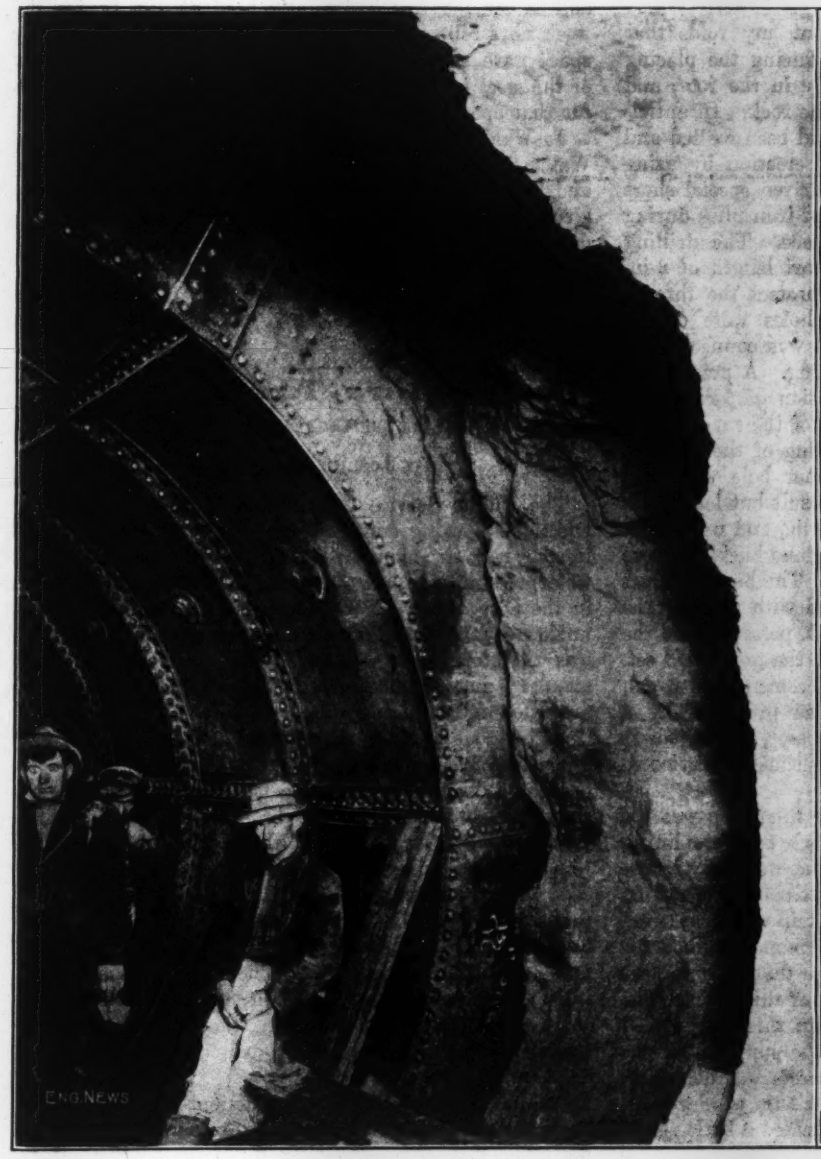


FIG. 8. END OF STEEL INTERLINING, SHOWING STEEL DIAPHRAGM RIVETED INTO PLACE

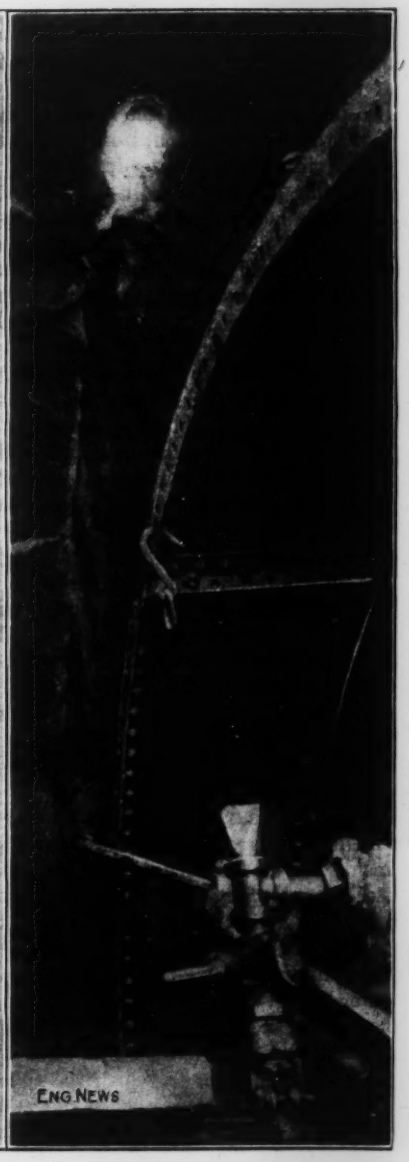


FIG. 9. CUTTING GROOVE FOR STEEL DIAPHRAGM

low the invert was filled with 1 to 1 grout poured in through a grout hole in the bottom of the steel interlining. Grout pipes extending the full depth of the groove were placed in the invert, at the springing line and in the roof and concreted in.

After the concrete was thoroughly set, the 2-in. annular space outside the steel interlining was filled with grout, using the 2-in. grout holes provided in the segments of steel interlining for that purpose. These holes were formed by a threaded casting riveted to the steel to which the grouting apparatus was attached. A liberal number of segments with grout holes were provided and during erection they were placed at frequent intervals in the invert and arch and in the upper and lower quarter points. The spacing was not over 30 ft. for a maximum and usually much less. Grouting was begun at one end with a connection at the invert and to avoid forcing the grout to travel too far at least three connections were made. All holes were kept open as the grout rose and were not closed until a free and continuous flow of well mixed grout appeared. After the space was filled to a height of about 3 ft., connections were made to the holes in the crown and the grouting completed. The interlining was sounded with a hammer during the filling to expel the air and aid in insuring a complete filling at the top. After the grout had set, the grout holes were closed with cast-iron plugs. The grout was placed with a light pressure at first and reached a maximum of 60 lb. when finishing. The mix was 1 bag of cement, 1 bag of sand of about 0.9 cu.ft. volume and 85 lb. weight and about 12 gal. of water. Two grouting tanks of the Caniff type mounted on a movable truck were used, thus giving an almost continuous flow of grout.

GROUTING BACK OF THE OUTER CONCRETE LINING—

After the grout had sufficiently set, holes were drilled through to the rock in order to grout any voids that might have been left along the rock during the placing of the outer concrete lining, especially in the roof, and also to endeavor to fill the seams in the rock. In anticipation of this operation, 2-in. holes had been drilled and tapped in the steel interlining after erection by using a portable pneumatic drill and hand-driven special short tap. The holes were closed with a cast-iron plug during the grouting of the 2-in. annular space. The drilling was done chiefly with jap drills, a short length of 2-in. pipe being screwed into the hole to protect the threads and also to guide the drill. The holes were drilled through to the rock. The grout hose was connected directly to the hole in the steel interlining. A pressure of 200 lb. was tried first with the intention of forcing the grout as far as possible into the seams of the surrounding rock, but this caused an inward buckling of the steel interlining near the connection. Another hole was tried under 80 lb. pressure with a similar result but less in extent. The pressure was reduced to 50 lb., and no further trouble was experienced. The plates alone buckled, there was no deformation of the rib angles. The buckled areas were tapped where necessary and filled with grout. The grouting was completed using the 50 lb. pressure, and the holes closed with cast-iron plugs after the grout had set. Neat grout was used, mixed 1 bag of cement and 6 gal. of water. The 200 lb. pressure was produced by a Westinghouse high-pressure air compressor, taking power from the low-pressure air line at that time in service in the tunnel.

THE CONCRETE INNERLINING—The final step was the placing and grouting of the 8-in. thick concrete lining inside the steel interlining to form the waterway. The steel was thoroughly cleaned and a strip of invert 4 ft. wide laid along the bottom. On this strip the forms were erected and the lining placed, the forms and method for the cylindrical portion being similar to that used for the outer lining, described in the first part of this article. The horizontal member of the form was in this case placed a little below the axis, and formed the support for the track and platform on which the concrete was delivered. In the conical portion, wooden ribs and 4-in. wide wooden lagging were used. The concrete was mixed a little richer than 1 to 6. The coarse aggregate was 1 in. maximum diameter.

To insure complete filling around the legs of the angles of the steel interlining at the top, grout pipes were set when the concrete was placed, and the space afterwards filled with neat grout under about 25 lb. pressure. The pipes were set on the north side of every circular rib of the interlining. At first, two pipes were placed about 1 ft. either side of the crown, but later two additional pipes were set, one on each side just below the angle at the lower end of the crown segment. Grout pipes were also set in the conical portion and grouted at the same time as those in the cylindrical portion. Not all the holes required to be connected to, but at least one connection was made for every 3 ft. in length of tunnel and all holes not showing a flow of grout were connected to and sealed.

TEST—The hydrostatic test of the entire tunnel under the full working pressure indicated that the work was thoroughly done, for no leakage could be detected nor were there any suspicious phenomena. The work was under about 100-ft. head continuously for three months and under the full hydrostatic head of 168 ft. for the week next following. The grouting of the 2-in. annular space gave a very good demonstration of the tightness of the steel interlining under the moderate pressure used for that operation.

J. Waldo Smith is Chief Engineer of the Board of Water Supply, Frank E. Winsor, Department Engineer, and Chas. E. Wells, Division Engineer in charge of construction, Alfred D. Flinn, Department Engineer, Headquarters, and Thos. H. Wiggin, Senior Designing Engineer, were in charge of the design. The contractor was Geo. W. Jackson, Inc., of Chicago.

Manufacture, Test, and Use of Waterproofing Fabric

BY JOSEPH ROSENZWEIG*

The Public Service Commission of New York (First District) is using enormous quantities (4,000,000 sq.ft. in the last six months) of treated woven fabrics for waterproofing the new subways now under construction in the City of New York. It was found difficult to get uniformity in the product, and a study of the subject was therefore made by the writer for the purpose of standardizing the manufacturing and testing of these saturated fabrics.

Waterproofing fabric is made of burlap saturated with asphalt or coal-tar pitch, and sprinkled with woodflour to prevent self-adhesion. Burlap is made of jute, which is the fiber obtained from the inner bark of the Asiatic plant, *Genus Corchorus,* of the Linden family. The woodflour is pulverized or granulated pulp, chiefly of cedar or white pine. Most of the burlap used for waterproofing is received from Dundee and Calcutta, in bales or rolls of from 1200 to 2000 yd. in length, the width being from 32 in. to 42 in. The finished fabric comes in rolls of from 100 to 200 yd. in length, the width varying sometimes from 29 to 39 in., the variation from the original width of burlap being caused by shrinkage due to saturation.

As the Public Service Commission is using coal-tar pitch for membrane waterproofing exclusively, it is highly desirable that the saturating flux and coating of the fabric should conform as closely as possible to the binder, and as heretofore no jute fabrics had been saturated and coated with coal-tar pitch, experiments were conducted to determine whether this could be done, and eventually it was found that fabric of this nature could be produced, and it is now used on our work, together with asphalt-saturated fabrics.

REQUIREMENTS OF FABRIC

It has been found that good waterproofing fabric must possess the following qualities:

1. The fabric should be thoroughly saturated and well coated, leaving sufficient open mesh to permit the proper bonding of successive plies.

2. The fabric should be sufficiently pliable so as to conform to the unevenness of the surfaces to which it is applied.

3. The burlap while being saturated should not be

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charred, which may happen if the temperature of the saturant is very high.

4. The saturant should be of such material as not to have a deleterious effect on the burlap.

5. The finished roll of fabric should be easily unrolled, only sufficient woodflour to prevent self-adhesion being used.

6. The completed roll of fabric should be protected from warping, wrinkling or other injury by the insertion of a central core or spool made of wood or fiber.

7. The saturating flux should have a melting point of at least 140° F. and its temperature during the saturation process should be between 270 and 300° F.

To produce the above, experiments have shown that the burlap must be drawn through the saturant very slowly and remain immersed for as long a period as is required to draw a maximum of 10 ft. of the burlap through the saturant in 30 sec. when the saturant is at 270° F., the speed being proportionate to the temperature of the saturant, that is, the hotter the saturant, the less the time of immersion, and *vice versa*. This speed may be increased if the burlap is to receive a coating besides the saturation; that is, if the double process is to be used. The melting point of this coating flux (which is not to differ materially from the saturating flux) may be twice that of the saturant, but its temperature at the time of application must be the same as that of the saturant to effect complete adhesion.

Manufacture of Fabric

The method of saturating the burlap found to be most practicable and now in general use is as follows: A roll of burlap is passed through a series of hot rollers or hot coils for the purpose of evaporating all moisture, which sometimes amounts to 10% by weight, and never less than 3%. It is then rerolled (unless coils or rollers are near the saturating tank) and set up in a revolving stand in front of a long but shallow steel tank through which it is drawn at a depth of about 1 ft. below the surface of the saturating material contained therein, for a distance of about 15 ft. A short but very deep tank is equally as good as a long but shallow one, the burlap traveling through it vertically instead of horizontally. The saturant is heated and kept to any required degree of temperature by steam coils placed along the vertical walls of the saturating tank on the inside. From the tank it is drawn through two steam-heated compression rollers. The function of these rollers is to remove the excess saturant clinging to the burlap and press the remaining saturant into it. The pressure exerted by these rollers determines the percentage of open mesh remaining in the saturated product.

The saturated fabric is next drawn over an air space whose practical horizontal limit is about 20 ft. with the machinery used in most manufacturing plants, or drawn alternately over water-cooled rollers with bearings on floor and ceiling, whence it is sent over a series of drying rollers, which may be large or small, their function being merely to expose the saturated fabric for as long a period as is practicable to the cooling effect of the air. Instead of the open air space, a strong electric blower properly placed will accomplish the same result. The drying rollers are also used to spread on the surface a thin film of woodflour, after which the fabric is wound upon a collapsible spindle, from which it is easily removed, a simple measuring device showing that the required length has been rolled up. A core above referred to is then inserted, or the fabric may originally be rolled thereon, and the roll is then ready for shipment.

The burlap should show a uniform open mesh with a uniform thickness of thread in warp and woof, and in drawing it through the series of rollers for saturating purposes, care must be exercised not to subject it to too great a tension, as this distorts the mesh and weakens the fabric. The best burlap to use has been found to be that of between 7 and 8 oz. per sq.yd. incl. in weight. The saturating material may be either a pure or fluxed asphalt or a coal-tar pitch. There is no positive proof that asphalt is preferable to pitch as a binder or saturant, but in view of the fact that a coal-tar pitch is now used exclusively as a binder in the field for bonding the various plies of fabric, it is preferable as a saturant because asphalt and coal-tar pitch do not mix well.

Experiment has shown that while all asphalts are capable of being acted upon by acids, coal-tar pitch is affected by them to a much less extent. The asphalt should not be too brittle if fluxed; that is, if an asphaltic oil and gilsonite or grahamite are mixed in certain proportions to form commercial asphalt; the coal-tar pitch, on the other hand, should not contain more than 10% free carbon, because carbon, as well as the burlap proper, is not a waterproofing material, carbon giving body to the saturant, so to speak, and the burlap giving body or acting as reinforcement to the waterproofing membrane.

It may be asked, Why saturate burlap at all? To which the answer is, that workmanship in the field with reference to waterproofing a subsurface structure is not entirely dependable; the temperature of the binder is not constant, and often below what is necessary to saturate the raw burlap. It may also be asked why woodflour alone is satisfactory for preventing self-adhesion. Because anything else, such as soapstone, cork flour, powdered sand, or even coarse sawdust, is not absorbent, adds unbeneficially to the waterproofing membrane, and hinders the affinity between the binder and the saturating flux when the fabric is applied in the field. It should be noted, that experience with various woodflours has definitely demonstrated the superiority of one of a fine granular nature over any other form.

It has been suggested that creosote, being an excellent preservative of wood, and a distillate of coal tar, would be an equally good preservative for burlap. The objection to this lies in the fact that creosote evaporates very quickly, leaving the fabric stiff and unprotected against mechanical injury.

Tests for Acceptance

Experience has shown that the following inspection methods reveal whatever is good or bad in waterproofing fabric:

1. Observe the surface of the fabric through a magnifying glass and note whether the individual strands are merely stained or actually coated with the saturant, the former being entirely insufficient.

2. Hold a large piece of the fabric before a light and note the percentage of open mesh, which should be approximately 50% of the untreated burlap. This percentage of open mesh insures good coating, but not necessarily good saturation.

3. Cut off a piece of fabric about 1 ft. square from a roll selected at random, and with a sharp knife cut it parallel to the warp, parallel to the woof and diagonal to both. This will not always reveal insufficient saturation, but by ripping the fabric along the line of these cuts, this defect will become visible and show the fabric to be unsatisfactory.

4. Flexibility and a certain degree of softness of the fabric are essential requisites. These may be discovered by crushing the fabric in the hand held close to the ear; if a crackling sound is heard, or flakes peel off, it shows that the asphalt is too hard or the coal-tar pitch is of too high a melting point. The fabric will also feel stiff if either is the case.

5. A square foot of the fabric should be cut from any portion of the roll and carefully weighed to determine the amount of saturation; this should equal the weight of the raw burlap, thus making the finished product twice the weight of the raw, and this should be a minimum.

6. Since an excessive coating of woodflour is undesirable, and even injurious, the finished roll should be unwound, and if its appearance is distinctly white, as it is when too heavily covered with white pine woodflour, it should be rejected; the amount of woodflour permissible being 3/8 lb. per square, that is, per 100 sq.ft. of surface, uniformly spread on one side only. In hot weather, 1/2 lb. per square is permissible.

7. To determine the effect of the saturant on the burlap, for it is sometimes injurious to its tensile strength, the fabric should be tested in a tension machine; a well saturated fabric will always show an increase in strength over the raw burlap, but when tested in strips 1 in. in width, it should show not less than 80 lb.

8. A sample of the saturating flux should show on chemical analysis the following:

Solubility in carbon tetrachloride, not less than 98%.
Solubility in petrolic ether, not less than 66%.

Physical tests should show:

Softening point, not less than 75° F.
Melting point, not less than 140° F.
Penetration, not less than 0.75 cm.
Penetration of coating, not less than 0.15 cm.
Ductility of saturant, not less than 50 cm.
Ductility of coating, not less than 5 cm. when elongated at the rate of 5 cm. per minute in water at 77° F.

9. The woodflour should be preferably a fine granular cedar applied as a thin, even film on one surface only, but if sawdust is used, it should be sparsely applied.

10. When the fabric is brought on the work, it should be stored in a dry and cool place, piled no more than three or four rolls high, protected against rain and other weather conditions, as well as from injury by resting or falling weights.

It should be noted that in hot weather a saturating flux with a higher melting point should be used than that employed during the winter, but the former should not exceed 160°, and the latter should not fall below 140°; that the amount of woodflour should be reduced as the weather grows colder, and all quantities lying loose should be swept off.

An open-mesh saturated fabric is now recognized by most engineers to be superior to the saturated felt for waterproofing purposes, as it is now employed in what is known as the membrane method of waterproofing. The reason for this conclusion is found in the fact that an open-mesh fabric permits a more thorough bonding of the successive plies of fabric with the binder, and permits the escape of air from pockets formed underneath the layer of fabric on and before the application of the binder to the surface. A substitute has been suggested in the form of perforated felt, saturated in the same way as fabric. This is simply recognizing the efficacy of open-mesh fabric which is free from the disadvantages inherent in the perforated felt, viz.: distinct layers in the form of alternate stratas; lack of tensile strength; lack of amalgamation of materials and a tendency to "creep," especially on vertical walls; while the fabric possesses the advantage of acting as a reinforcement and body-giver to the membrane, being more elastic and capable of yielding over a considerable area.

Tie Treating Plant, Louisville & Nashville R. R.

SYNOPSIS—A railway plant of recent construction, notable in employing two processes; creosote treatment for ties on curves, and zinc-chloride treatment for ties on tangents. The pipe systems for handling the treating liquids are entirely of cast-iron flanged pipe. The plant treats about 60,000 ties per month.

A notable feature in relation to the increasing use of treated ties is the increase in the number of railway plants for tie treatment. Among the facts which lead to this development are: (1) A desire of the railways and railway engineers to keep control of the treatment of their own ties, and (2) the importance of maintaining a minimum haul of the ties. Estimates of the economy due to the use of treated ties do not always give sufficient weight to the matter of cost of transportation, but careful calculations as to this show that in many cases a long haul may seriously impair the economic value of treated ties.

The Louisville & Nashville R.R. has for many years been treating piles and bridge timbers by the creosoting process at its West Pascagoula plant, near Gautier, Miss., but this was largely as protection against the teredo and other destructive organisms in salt water. The railway had an ample source of supply for its ties (the standard material being white oak), but with the outlook for a decreasing supply and increasing cost of first-class untreated ties, it began to consider the possible economies due to the use of ties of inferior timber treated by preservative processes, and about a year ago it was decided to undertake the treating of ties.

The question of the location of the plant was one of the first points to be considered. For a railway obtaining all its ties from one district, a single large treating plant may be economical, but this railway obtains its ties all

along the various lines of its system and it was easily shown that one large plant would not be economical, in view of the fact that cost of transportation is a large proportion of the cost incidental to treatment. The cost of haul per tie was estimated at 4c. per 100 miles, while the cost of treatment (exclusive of chemicals) was about 5c. per tie, so that it would not pay to haul the ties much more than 150 miles. It was considered the better policy, therefore, to establish two or three plants at different points so as to economically serve the different portions of the railway system.

The first of these tie-treating plants is that now in operation at Guthrie, Ky. This place was selected as being at the intersection of two important divisions, one extending from Nashville north to Henderson (on the Ohio River) and St. Louis, and the other extending from Memphis to Louisville. Thus ties are readily received and distributed, and the plant will serve the entire northwestern portion of the system.

The special features of the plant may be noted as follows: (1) The use of two preservatives, creosote oil for ties on curves (with tie plates) and zinc-chloride for ties on tangents (without tie plates). (2) The compact arrangement of the plant, with low cost of construction and operation, and special facilities for inspection of the intricate piping systems. (3) The fireproof construction of the buildings. (4) The use of cast-iron flanged pipe for all lines handling oil or zinc. (5) The steam-heating systems for the cylinders and tanks, avoiding the use of coils and pipe joints. (6) The economy in fuel consumption, due to compact arrangement of the plant and to the use of exhaust steam for heating feed water.

The plant was put in operation in March, 1914, and is treating about 60,000 ties per month. Its total cost was about $161,000, including $45,000 for the yard. The plant was designed by the railway company's engineers, and all parts were built and furnished to specifications. The buildings were erected by contract, and the equipment was supplied by various manufacturers. The grading was done by contract, and tracklaying was done by the railway company. The design and construction were under the direction of W. H. Courtenay, Chief Engineer of the Louisville & Nashville R.R., and J. B. Lindsey, Superintendent of Timber Treating Plants; H. G. Laird is Assistant Superintendent in charge of operation.

General Plan

The plant is located near the station at Guthrie, and is served by tracks connecting with both of the intersecting divisions. It occupies a tract of about 30 acres, giving ample yard room for the storage of ties for seasoning. There is room for about 500,000 ties in the yard, which is well equipped with water mains and hydrants for fire protection. The water pressure, about 25 lb., is maintained by an elevated tank of 50,000 gal. capacity.

The soil is a stiff red clay, and the foundations simply require footings in this; no piles are used. A creek running diagonally across the site has been filled up, and its course diverted to two 20-ft. drainage ditches, paralleling the longer sides of the yard and discharging through culverts in the railway embankment at the north end. The excavated material was used to fill low places in the yard. The site has a slope toward the east, and open drains are cut across the yard to drain surface and subsurface water to the ditch on the east side.

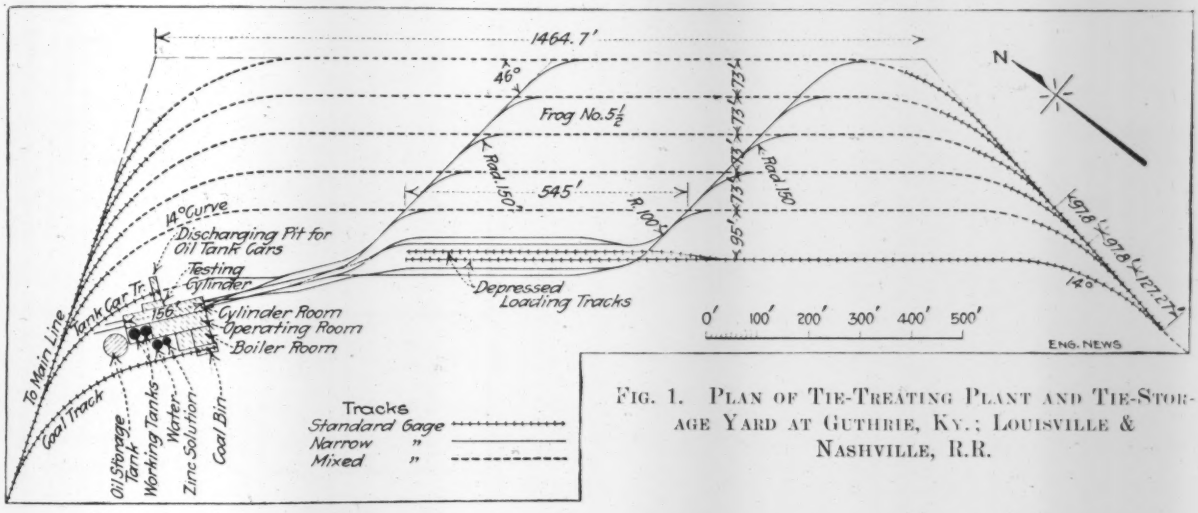

Fig. 1. Plan of Tie-Treating Plant and Tie-Storage Yard at Guthrie, Ky.; Louisville & Nashville, R.R.

The layout of the plant and yard is shown in Fig. 1. The connection at the north end is with the Louisville-Memphis main line, while that at the south end is with the St. Louis-Nashville main line. The standard-gage and mixed-gage tracks are laid with 70-lb. rails (Am. Soc. C. E. section), and the narrow-gage (30-in.) tracks with 58¼-lb. rails. The standard-gage tracks have 12-ft. switches and No. 7 frogs. There are several intersections of narrow-gage with mixed-gage tracks, and these are built of 70-lb. rails.

A locomotive is used for handling the railway coal cars, tank cars and carloads of ties, as well as for handling the tie trains on and out of the cylinders. This machine is available for general use and is considered more satisfactory and economical than a cable haulage plant for the cylinder trains. It is a four-wheeled engine, weighing 65,000 lb., and while this is not at all too powerful for the work, it represents about the maximum weight for a four-wheel engine of 30-in. gage. A six-wheel engine could not well be used on account of the sharp curves in the yard tracks. The front end of the

frame is fitted with a heavy bumper for pushing the cars. It pushes the rear end of the tie trains into the cylinder by means of a pole, so that the engine does not run onto the transfer table. It hauls the train out by a cable extending the full length of the train. A notable feature is the use of the Walschaerts valve-gear on a narrow-gage industrial locomotive of this size.

The tie cars are of structural steel, with pressed-steel ribs forming the lower part of the hoops, which hold the ties in place. They run on 12-in. wheels. Each tie train consist of 15 cars, with about 45 ties per car.

The railway cars for shipping the treated ties are placed on two standard-gage tracks, which are depressed so as to bring the car floors about level with the yard surface. This is considered preferable to running the tie cars on an elevated loading platform. This loading pit, Fig. 2, is 28 ft. wide and 4 ft. deep (to rail level). It has 6-in. reinforced-concrete walls, 7 ft. high, with counterforts 10 ft. apart and expansion joints at intervals of 85 ft.

Treating Plant

The treating plant is located at the northwest corner of the site, and has two cylinders or retorts, with provision for a third in the position now occupied by the testing cylinder. The general arrangement is shown in

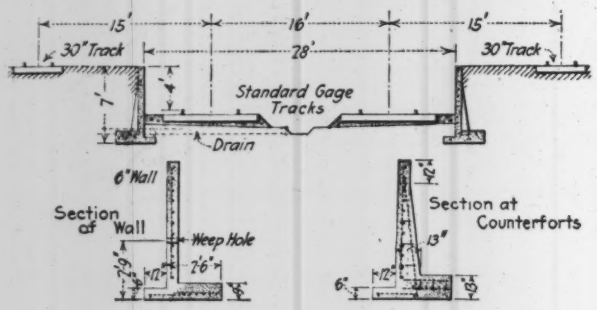

Fig. 2. Section of Loading Pit

Fig. 3. The cylinders are housed in one side of a building, which contains also the boiler room, the valve or operating room and a repair shop.

The building also incloses the working tanks, but is not carried up high enough to roof over these tanks, as this would have made an expensive construction. Instead, the upper part of each tank, above the roof, is inclosed by a steel jacket, whose lower end opens into the building while its upper end carries a roof just above the tank roof. Thus the hot air of the building passes up through the 4-in. space around the tank and roof.

The storage tanks are outside the building, but very close to it, so that the outdoor pipe connections are very short. These pipes are in concrete trenches, protected from the weather and readily accessible.

One of the special features of the plant, as noted above, is the use of cast-iron flanged pipe for all lines handling oil and zinc solution. This is in order to avoid the trouble of leakage at threaded joints, due to the liquid working along the threads or causing their corrosion, while the cast-iron pipe also gives better resistance to the action of the zinc and creosote. The additional cost was slight, but the pipe system had to be very carefully laid out in advance, since the parts had to be cast to specified lengths and could not be cut and adjusted like steel or wrought-iron piping. The piping is arranged with a view to accessibility and to convenient location of all valves and fittings.

The two cylinders, 7 ft. in diameter and 130 ft. long, are fitted with a single sap drum for drainage. They were shipped from the maker's shops in two lengths. Both ends have doors, but that at the south end is used as the charging door. Each of these doors is carried entirely by its two heavy hinges, no overhead or bottom support being used, and is secured by 36 hinged bolts 2¼ in. diameter. The cylinders (which are heavily lagged) rest on saddles on concrete piers 12 to 16 ft. apart. The central saddle is anchored, but the others are fitted with rollers to allow for expansion movements. In front of the two cylinders is a pit for a short transfer

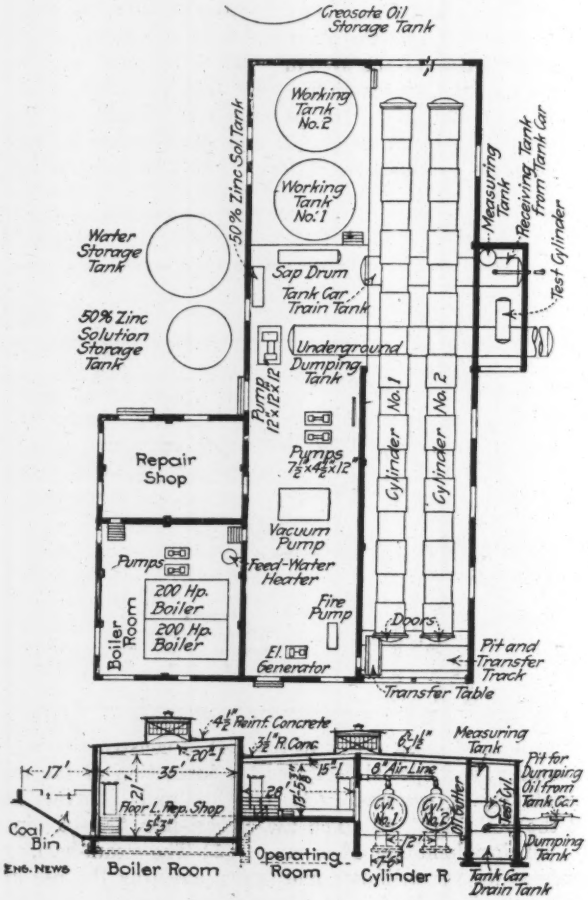

Fig. 3. Plan and Sectional Elevation of Tie-Treating Plant; Louisville & Nashville R.R.

table, which connects the yard tracks with the cylinder track when the door is open. This end of the building is open, but a partition is built across it at the rear of the pit, so as to exclude cold air from the cylinder room.

The creosote oil is delivered in tank cars, and each car is spotted over a concrete pit or hopper, having an 8-in. pipe leading to a receiving cylinder in the basement. From this the oil is pumped to the storage tank. The oil for the cylinders is fed from the working tanks, and after a charge has been treated the oil is drawn off into

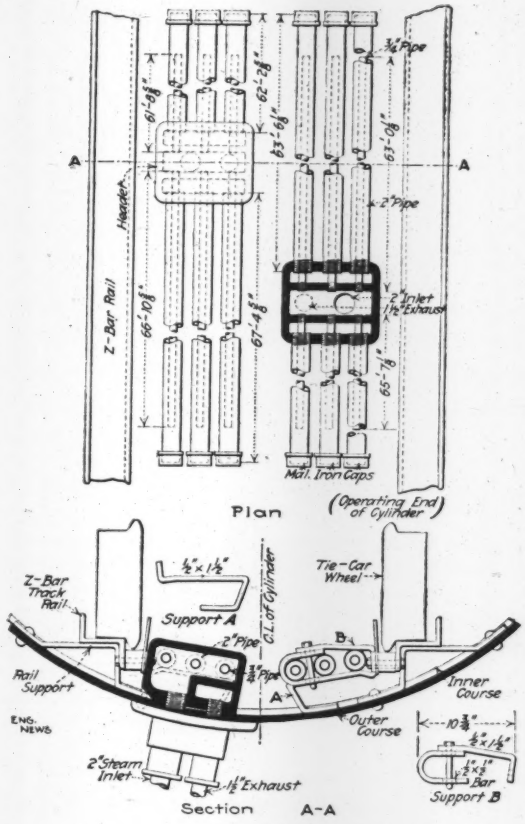

FIG. 4. TRACK AND STEAM-HEATING EQUIPMENT FOR TIE-TREATING CYLINDERS

a dumping tank in the basement, from which it is pumped to the storage or working tanks as required.

The zinc solution (50%) is also delivered in tank cars, but these have no bottom discharge. A portable pipe connection is made to the top manhole, and the solution pumped to the zinc-storage tank. The measuring of the oil and zinc solution is done by means of float gages.

For experimental work there is a cylinder 11 ft. 6½ in. x 3 ft. 7½ in., served by a measuring tank, as shown.

The heating system of the treating cylinders is of novel design, and is one of the special features of the plant. It eliminates the use of pipe coils, with the troubles incidental to keeping the joints tight, which result in oil leaking into the pipes and water getting into the oil. As shown by Fig. 4, the steam is delivered to cast-iron headers bolted to the shell of the cylinder near the bottom, and from these ¾-in. pipes extend in both directions; these pipes are inclosed in 2-in. pipes of slightly greater length, through which the steam returns to the header. The end of the larger pipe is closed with a heavy cap.

The pipes are supported and held at intervals by saddles of steel bars. The headers are placed on opposite sides of the center of the cylinder, thus leaving the bottom unobstructed for draining out the cylinder. The tie-car track in the cylinder is composed of Z-bars, with plate guard rails. The storage tanks are heated by steam pipes in the same way as described for the treating cylinders, but the larger pipes have the ends closed with heavy plugs welded to the pipe and made convex in order to resist the cutting action of the steam. Each tank has two sets of pipes, placed at right angles to each other, and attached to headers or manifolds bolted to manhole openings, as shown in Fig. 5.

The pump equipment includes the following: One duplex crank and flywheel pump, 10x16x12 in. for vacuum, one duplex piston pump 12x12x12 in. for pumping the preservative, one 7½x8½x10-in. duplex pump for pumping oil and 50% zinc solution, two 7½x4½x12-in. pressure pumps for the solution, and two boiler-feed pumps. No compressed air is used either in the treatment or for handling material. A small steam generator set supplies current for electric light in the building. On the gage board in the operating room are vacuum, steam-pressure and recording gages for each cylinder. An electric bell is rung by a float when the cylinder is full.

Steam is supplied by two horizontal water-tube boilers of 200 hp., one of these being held in reserve. A large feed-water heater is placed in the boiler room. Coal is delivered in cars which are run over a concrete trestle to a 100-ton concrete bin. This is alongside the boiler house, and the bottom slopes toward openings in the wall, so that the firemen can handle the coal direct from the bin to the boilers. Coal costs about $1 per ton. The fuel cost per tie is only about 0.18c. per tie, this very low figure being due largely to the use of exhaust steam for feed-water heating and to the compactness of the plant.

TREATMENT

The tie-treating policy on this railway is somewhat unique, in that it provides for the regular use of two

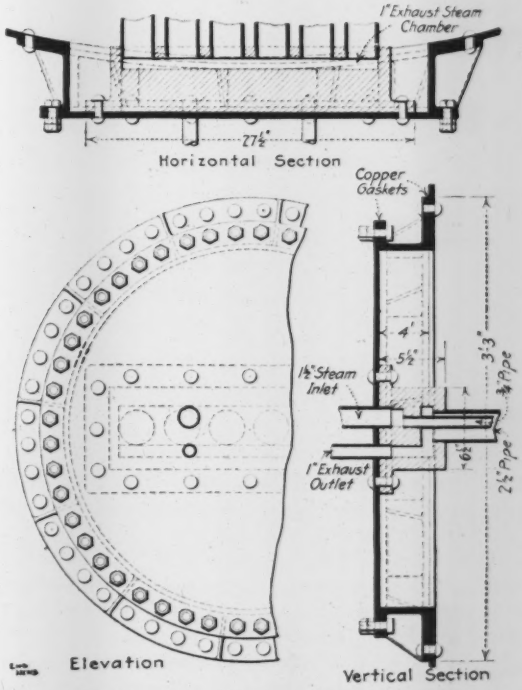

FIG. 5. STEAM-HEATING EQUIPMENT FOR OIL TANKS

distinct processes. Ties for tangents, on which no tie plates are used, will be treated by the straight zinc process. Ties for curves, all of which have tie plates, will be creosoted. The zinc process is by far the cheaper, and

a consideration of the use of creosoted ties on tangents, with metal tie plates, showed no economy over untreated white-oak ties without tie plates.

The economics of the case may be explained as follows: For ties on tangents the cheaper zinc process will make their resistance to decay about equal to their resistance to mechanical wear. In other words, when the ties need renewal, it will be on account of both decay and wear, and they will thus have given their full service life. On curves, however, the treated ties would be worn out by the rails long before their decay, unless protected by tie plates. But with this protection the effect of the zinc preservative would have disappeared long before the tie was worn out, and in order to equalize the resistance to wear and decay under curve conditions it is economical to use the creosoting process, which is higher in first cost but gives a longer life than the zinc treatment. To apply creosoting and tie plates for all ties (on tangents as well as curves) would be too expensive under the conditions existing on this road, and advantage is taken of the economies made possible by the use of the zinc process.

The wood used is red oak having a life of about four years untreated. The ties are 7x9 in., 8½ ft. long. The metal tie plates are 7x8½ in., ½ in. thick, with a shoulder on top and with two shallow ribs (across the tie) on the bottom. The latter are just large enough to give the plate a hold on the tie without injuring the wood.

The creosoting is done by the full-cell process, and is designed to impregnate the timber with 8 lb. of creosote oil per cu.ft. A 24-in. vacuum is obtained in about 30 min., and is then held for 2 hr.; the creosote is then admitted and a pressure of 150 lb. maintained for about 3 hr., after which 15 min. is allowed for the timber to drain, before the cylinder is opened and the charge withdrawn. The zinc process is very similar, and is designed to give ½ lb. of dry zinc per cubic foot of timber. The zinc chloride is purchased as a 50% solution, and a 4% solution is used in the treatment.

The oil is required to be a coal-tar creosote (free from any other oil or tar) having a specific gravity at 30° C. of at least 1.03%, and containing not more than 2% of water. An average of the test analyses from five tank cars show a distillate as follows:

	Per Cent.		Per Cent.
0° to 210° C.	2.2	Total	59.3
210 to 235° C.	22.0	Residue	40.7
235 to 240° C.	3.8		
240 to 270° C.	14.7	Total	100.0
270 to 316° C.	15.6		

The ties are inspected at the points of shipment by special inspectors of the Tie and Timber Department (instead of by the various road-masters), and when stacked in the storage yard they are marked with the month and year. They are arranged in consecutive or chronological order as far as possible, thus facilitating the work and reducing the cost of yard switching in making up the cylinder trains. The ties remain in the yard for nine months before treatment. The zinc-treated ties are shipped promptly after treatment, and the creosoted ties are shipped out at once, as holding them would only result in allowing more of the lighter oils to escape.

The ties for seasoning are stacked in piles of 100 each, with two ties at the bottom and ten layers of nine ties each, the adjacent layers being in contact at one end and separated at the other end (alternate ends) by a single cross-tie. This gives a comparatively low pile, with plenty of air space.

All loading, unloading and handling is done by manual labor at piece-work. There is no difficulty in getting men (colored), and they make good pay while the company gets its work done at a low rate. The average untreated tie weighs about 220 lb., and a man will readily pull out a tie, tilt it on end and so get it across his shoulder and walk off with it with little apparent effort. In handling zinc-treated ties the men sometimes wear gloves, but in general they handle the ties with bare hands and appear to suffer no discomfort from the zinc-chloride or the creosoted oil.

Records of Treated Ties

All treated ties will have dating nails, having the last two figures of the year stamped on the head. These nails will be driven in the ties when they are placed in the track, and the position of the nails in the tie will also show in what year the tie was placed, so that if the figures on the nail become obliterated the age of the tie will still be known. To determine the life of treated ties, stretches of track will be laid with 500 treated ties each. Records of the treatment of the ties in these stretches will be preserved at the tie plant, while a careful record of the location of the test tracks on the various divisions (as well as record of removals of these treated ties) will be kept by the roadmaster of each division.

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Tests of Electrolysis Mitigation by the U. S. Bureau of Standards continue; the second of its "Special Studies" is reported in Bulletin 32 on tests of system of insulated negative return feeders in St. Louis, Mo. The engineers of the Bureau secured the coöperation of the United Rys. Co. for the use of the track network supplied by the new Ann St. substation. Eight 1,000,000-circ. mil negative-feeder lines were run in three directions, north, east and southwest, each feeder being 1500 to 4000 ft. long. They were arranged to be tied, for tests, into tracks and water and gas mains as either insulated or uninsulated negative feeders (according to the scheme described in "Engineering News," Feb. 26, and Apr. 2, 1914). They were designed to reduce the track potential gradient to one volt per 1000 ft. average for one hour peak load, which would correspond to a 24-hour average of 0.46 volt. Measurements were made of rail gradients, current in pipes, potential between pipes and rails, over-all potential and feeder current. Under the insulated-feeder system, but one point was found with greater than 1 volt per 1000 ft., and the 24-hour average of all was 0.46 volt (corresponding to one volt at peaks). Under connection as an uninsulated-feeder system, several points ran above 1 volt per 1000 ft., the 24-hour maximum being 2.89 (corresponding to 6.2 volts at peak load) and the average 0.93 (corresponding to 2 volts at peaks). The current flow in gas and water pipes under the insulated feed system, varied from 0.03 to 19.30 amp. with a total of 65.30; corresponding figures for same points under the insulated-feeder system were 0.17 and 56.4 amp. with a total of 273.25. Tying in the pipe systems to feeders gave total current values of 84.82 and 844.16 amp., respectively.

The potential differences between pipes and rails, at places which, before were above 1 volt positive, averaged 2.44 under the uninsulated and 0.33 under the insulated-feeder system. At places where the initial potential differences were below 1 volt positive, the new figures were 0.49 and 0.28. Where the initial potentials were negative there was a mean value of —0.31 volt under the uninsulated-feeder system; with the insulated feeders this became 0.56 volt positive. This is taken as showing that the extension of positive areas by the insulated negative feeders is not large enough but what it is greatly overshadowed by reduction of positive potentials, as the electrolysis diminishes more rapidly than the drop. The over-all potentials on feeders between the several outlying connection points and the substation were 2 volts per 1000 ft. average under the uninsulated system and 0.31 insulated. The data as a whole are considered to show that under the insulated negative-feeder system currents on underground structures are so reduced as probably to cause no trouble before replacement for other reasons.

New Railway Station at Memphis

SYNOPSIS—The new Central Station at Memphis, completed in 1914, was built in connection with the Illinois Central R.R. track-elevation work, and has both stub and through tracks. The through tracks are arranged singly, the alternate platforms being for passengers and trucking, while the stub tracks are in pairs. The subways are of different types of construction to meet the conditions, and are partly of steel and partly of concrete, but all steelwork is incased with concrete. One of the retaining-walls has a 4-ft. cantilever slab for a walk overhanging the street sidewalk. The subway construction and track elevation had to be done under traffic in most cases, and the plant and methods employed are described. The headhouse includes station facilities and several floors for railway offices.

The Central Station at Memphis

The city of Memphis, Tenn., with a population of 135,000, is served by nine railway systems, the passenger traffic of which is accommodated by two new union stations, with a third station maintained under franchise conditions which require the Illinois Central R.R. to have two stations. The two union stations are about a block apart, on Calhoun St., as shown in Fig. 1. A single station was at one time proposed, but unfortunately the coöperation of all the railways concerned could not be obtained.

Fig. 1. Map of Central Part of Memphis, Tenn., Showing the Railways and Railway Stations

Union Station—This is owned by the Memphis Union Station Co., and was opened in 1912. It is used by the following railways: the Louisville & Nashville, the Nashville, Chattanooga & St. Louis, the St. Louis, Iron Mountain & Southern, the St. Louis Southwestern and the Southern. It is a terminal or stub-end station, with Y-approaches to a line running (east and west) at right angles to the station and leading west to the Memphis Bridge over the Mississippi River. It is shown at *A* in Fig. 1.

Central Station—This is owned by the Illinois Central R.R. and is a through station on its line. It is used also by the Rock Island Lines and the St. Louis & San Francisco Ry., as well as the Yazoo & Mississippi R.R. (a part of the Illinois Central System), but these make it a terminal point, and do not run further north. The station is under construction and is expected to be completed by August, 1914. It is this station, marked *B* in Fig. 1, which is described in the accompanying article. When opened it will have a traffic of about 46 trains daily, four of which are through trains. There are four other through trains, but these back in and pull out again at the south end of the station.

Illinois Central R.R. Improvements

The Illinois Central R.R. line entering from the north runs parallel with and west of Main St., the tracks being at the foot of a bluff along the river front and on this part of the line is the Poplar St. station *C*. At Beale St. the tracks leave the river bluff and run in Tennessee St. at the street level to Huling Ave., where the passenger tracks make a sharp diversion to the east by a reverse curve to the station at Calhoun and Main St., beyond which they run approximately southward. The freight tracks continue south from Huling St., running around the industrial district and connecting with the main line again at Carolina Ave. The improvements include the elevation of the former surface passenger tracks from Huling to Iowa Ave. (with a maximum elevation of 15 ft.), the removal of the tracks in Nettleton St. (on the reverse curve) to an elevated structure on private right-of-way, and the construction of a new passenger station, power house and express building.

The old line had a grade of 2.4% from Huling Ave. down to Wagner Place and then 1% into the station, which made an unfavorable condition for heavy trains pulling out to the north. The new line rises from Huling St. on a grade of 1% to the new elevation, runs through the station on grades of 0.1 to 0.3% and then falls on a 1% grade to the grade crossing of the other railways (now elevated) at Railroad Ave. Beyond this it continues practically level till it meets the old elevation south of Iowa Ave.

A direct line eliminating the reverse curve approach at the north was desirable and was considered, but the cost of property to be acquired was considered prohibitive. The north end of this curve is about 20° and the south end 15°. To reach industry tracks on Nettleton St. there is a short spur track of 4½% grade down from the new elevation at Butler St., and another with a grade of 3.8% on a 30° curve at Wagner Place. South of the station are curves connecting the main line (north and south) with the east and west main line on Railroad Ave.

The Passenger Station

The station site extends from Calhoun Ave. to Georgia Ave., along the west side of Main St., a distance of 1200 ft. It has a width of 200 ft. between the retaining-walls along Main St. and along the freighthouse driveway (which is at the street level), and this is increased to 204 ft. by a 4-ft. overhang on the Main St. side. A plan of the track layout of the station is shown in Fig. 2.

While the station is used by four lines the Illinois Central R.R. is the only one which operates its trains through the station and north of Memphis, as noted above. Consequently the track layout includes both through and stub tracks. The double-track line from the north widens into a three-track approach which again opens out into five through tracks at the station. These tracks are not in pairs (as is the more usual plan), but are spaced alternately 23 ft. and 22 ft. c. to c., with 13-ft. passenger plat-

forms and 12-ft. trucking platforms at the wider and narrower spacing respectively. This arrangement will keep the passenger platforms free from baggage trucks.

Parallel with the through tracks there are five stub tracks entering from the south and terminating at the headhouse. These are in pairs with alternate spacing of 12½ ft. and 24½ ft. Their platforms will be used for both passengers and trucking, but the provision of baggage elevators at both ends of the platforms will reduce to a minimum the amount of trucking along the platforms. The length of the platforms is about 800 ft. at the through tracks and 600 ft. at the stub tracks, the latter having a 50-ft. cross platform at the end of the tracks. All of the platforms will be of concrete, but the temporary wooden platforms will remain until the new fill has settled thoroughly. They are covered with steel frame canopy shelters of the butterfly type, having a wood roof. The canopies are 14 ft. high and about 13 ft. wide.

At the south end, the ten station tracks converge into the double-track main line. The frogs throughout the terminal are Nos. 8 and 10, with No. 10 slip switches in the double crossover connections between the main tracks at each end of the station. These crossovers enable trains to be moved from either main track to any one of the station tracks. The through tracks and all turnouts are laid with 90-lb. rails in stone ballast, while 75-lb. rails are used in the straight portions of the stub tracks.

The station building or headhouse is 250x150 ft. at the street level, and is eight stories high, or 130 ft. from sidewalk to roof. A rather curious feature is that the upper portion (five stories) is smaller in plan than the lower portion which contains the station facilities. The lower part of the building, or the station proper, is in the Roman Doric style of architecture, and built of Bedford stone. The upper part is of red brick and terra cotta. The structural frame is of steel. The street level plan is shown in Fig. 3.

The upper floors contain the railway division offices, station offices and various facilities. The Illinois Central R.R. division hospital and medical service is installed here, and a doctor will be in constant attendance for the service of employees and passengers.

In this station the street entrance is at the lower level and the track floor is at the upper level, 15 ft. above. An unusual feature has been introduced to break up the flight of stairs, and that is the location of the concourse at an intermediate elevation, as will be seen by the cross-section in Fig. 3. Passengers entering from the street will find at hand the ticket office, baggage-checking counter, parcel-checking room, restaurant and lunchroom. A short flight of steps, only 8 ft. in height, gives access to the concourse, which serves as a general waiting room. Passengers going direct to the trains will pass across this to the gates leading to the stairways which give access to the several platforms. Passengers having to wait any length of time, can ascend a short flight of steps leading from the concourse to a waiting room which is at the side of the building and retired from the concourse. In connection with this are the toilet rooms, a nursery, and rest rooms for women.

As Tennessee is one of the Southern states having laws requiring separate accommodations for whites and colored people, there are special waiting, dining, lunch and toilet rooms for colored people, and these are arranged so as to be as independent as possible, the races coming together only at the concourse and the approaches to the trains. In addition to this, independent rooms and accommodations are provided for immigrants. A rather novel feature will be a telautophone train-announcing system (to be installed later), having loud-speaking "trumpets" or announcers fitted in the concourse, waiting room, etc. A pneumatic-tube system for messages will afford means of communication between the several offices and departments.

From the baggage room a rectangular concrete subway or tunnel extends southward through the station fill for nearly 700 ft., and connects with cross tunnels to the elevators at the south end of the platforms. This subway extends also to the express buildings at the southeast corner of the station. It has walls of concrete, heavily reinforced with steel, and a waterproofing composition was added with the water. The floor is finished with "ironite" to render it both hard and waterproof.

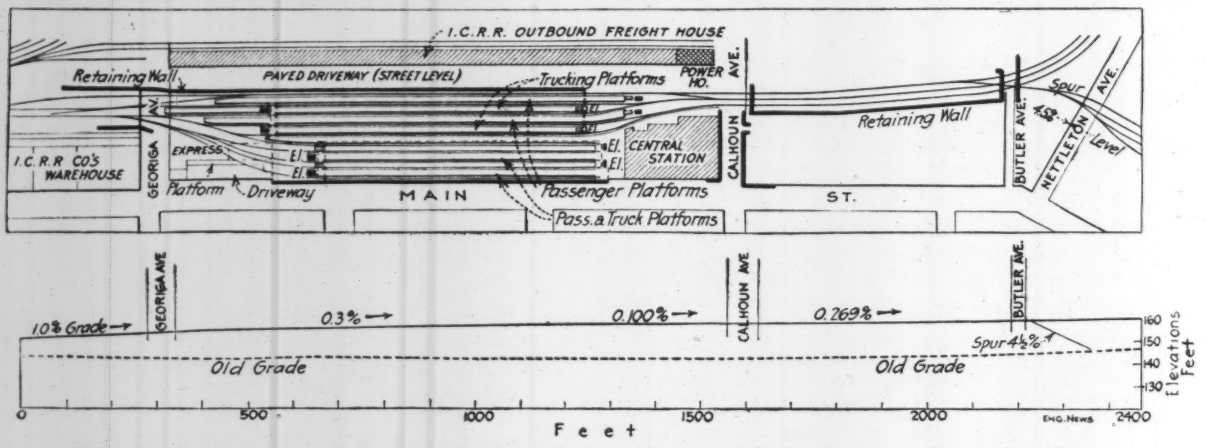

FIG. 2. PLAN OF THE NEW CENTRAL STATION AND ELEVATED APPROACHES AT MEMPHIS, TENN.; ILLINOIS CENTRAL R.R.

TRACK ELEVATION AND SUBWAYS

The track elevation eliminates the former six grade crossings at Carolina, Calhoun, Butler, Front, Wagner and Nettleton Ave., all of which streets carry heavy teaming traffic for warehouses and industries. At most of these crossings there was little change in the street

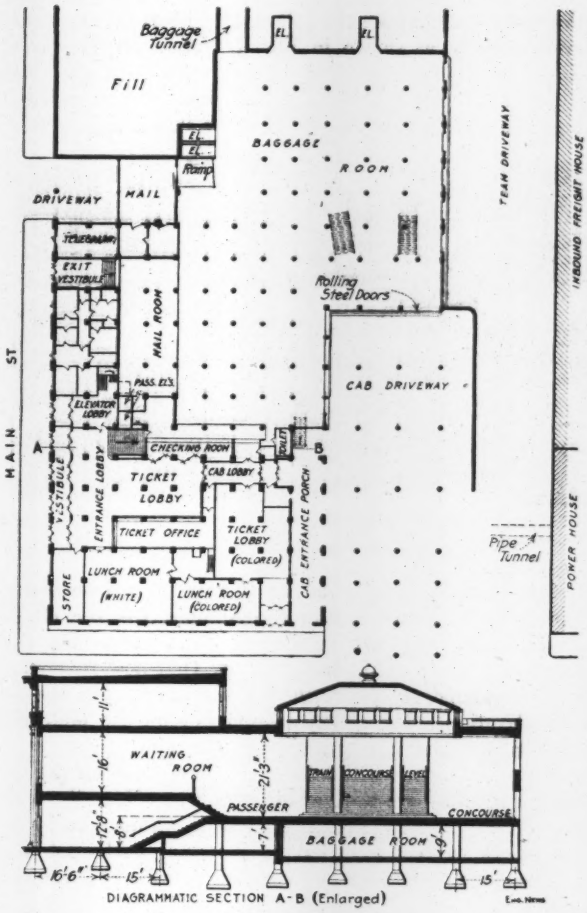

FIG. 3. PLAN AND CROSS-SECTION OF STATION BUILDING

grades, but Carolina Ave. was lowered considerably in order to give the required 12-ft. headway, as the elevation of the tracks here was governed by the approach to the railway grade crossing at Railroad Ave. The street approaches in this case are 4% at one end and 2.85% at the other. Both gravity and reinforced-concrete retaining-walls are used in different parts of the work, and all steelwork of the subways is incased in concrete.

The Carolina Ave. subway, Fig. 4, is 65 ft. wide between the abutments, and is 215 ft. long, carrying ten tracks. It has heavy gravity abutments at the street lines, and three intermediate supports or bents, spaced 23 ft. 9 in. c. to c. These intermediate supports consist of heavily reinforced footings, 18-in. circular columns (with spiral reinforcement), and a top or cap girder with semi-circular arches between the columns, which are spaced 6 ft. c. to c. The deck is made of reinforced-concrete slabs, cast in a temporary yard and set in place by a wrecking crane.

At the ends of the subway, the grades of the approach and the tracks made a shallower floor necessary. For the two tracks at the east end, there are three lines of 36-in. plate-girders (parallel with the tracks) having 12-in. I-beams across the lower flanges and a solid concrete filling between and over the I-beams and incasing the girders, as shown in Figs. 4 and 6. The deck is 19 in. thick at the middle and 15 in. at the abutment ends, covered with a 2-in. waterproofing course. For one track at the west end the deck is of longitudinal I-beams embedded in concrete. The concrete is 1½ in. thick beneath the I-beams and there is a sheet of expanded metal beneath the beams and embedded in the concrete. The exposed surfaces of the concrete, facing the street, are 40 in. deep and are relieved by panels recessed 2 in.

The Calhoun Ave. subway, in front of the station has two roadway spans 24 ft. 3 in. c. to c. of columns, a sidewalk span of 15 ft. 3 in. on the station side, and a similar span of 10 ft. 9 in. on the opposite side. It carries three tracks (14 ft. c. to c.) and is 44 ft. 2 in. long over all, with 14-ft. headway for the street spans, as there is an electric railway on this street. The three bents have steel columns supporting box girders parallel with the street line, all the steelwork being incased with concrete.

Longitudinal I-beams are framed between the webs of the box girders, the tops of the beams and girders being at approximately the same level, and the I-beams being embedded in a concrete deck which is 30 in. thick in the roadway spans. The concrete is shaped at the sides to form 18-in. curb walls (with iron railings), and the exposed faces represent fascia girders with paneled faces. For 300 ft. south of this subway, which is the space occupied by the baggage room and the cab and baggage driveway, there are steel columns incased in concrete and carrying a steel floor framing of girders and stringers, with a 6-in. deck slab reinforced with wire mesh.

The Front St. subway, Fig. 5, is 60 ft. between abutments. It is similar to the one at Carolina Ave., except that the floor over the roadway is of longitudinal I-beams (embedded in concrete) resting on the reinforced-con-

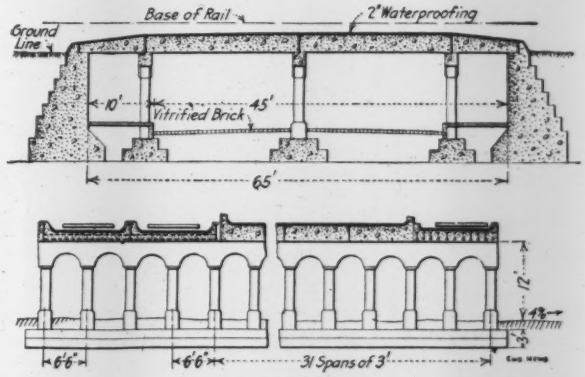

FIG. 4. THE CAROLINA AVE. SUBWAY AT MEMPHIS, TENN.; ILLINOIS CENTRAL R.R.

(Note the three different types of construction shown in the cross-section.)

crete bents, while concrete slabs form the sidewalk spans. The Butler Ave. subway (only 30 ft. between abutments) has gravity concrete abutments with a single 30-ft. span of the I-beam and concrete deck. This same construction, with 20-ft. span, is used at Wagner Place, where it forms a part of the skew bridge across Nettleton Ave.

The Nettleton Ave. subway is a complicated structure, due to its skew location (at an angle of about 30° with the center line of the street), the sharp curve of the tracks, and the fact that it extends across the intersection of Wagner Place. In this case the intermediate bents have columns 17 ft. c. to c. carrying heavy steel girders embedded in concrete. Upon these and the abutments are

laid plate-girders (in the parapet walls), and the I-beams of the floor rest upon the lower flanges of these girders. These I-beams are placed at right angles to the street line, so that, owing to the skew, many of them have one end carried by the lower flange of the main girder and the other end resting on the abutment or on the top of the cross-girder of the intermediate bent.

All the steelwork in the subways is wrapped with wire mesh and heavily cased in concrete. The street faces of the girders are paneled, and are rubbed down with carborundum blocks to remove form marks. The decks are formed with curb walls to retain the ballast, and upon these are erected iron railings. The standards for these railings are set in cast-iron bases so shaped that the sockets for the posts are over the outer line of the parapet, thus giving the maximum clearance between cars and railings.

The decks of the subways have a waterproofing course of felt laid in hot pitch and covered with 1¼-in. of mastic and sand, making a total thickness of nearly 2 in. This is turned up against the sides, where it is protected with a concrete strip. This construction is shown in Fig. 6, which represents the girder span of the Carolina Ave. subway. The backs of the retaining-walls and abutments

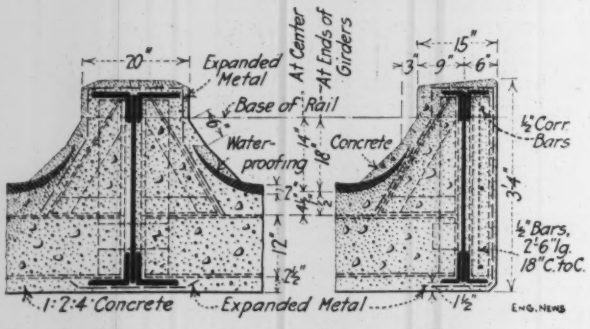

FIG. 6. WATERPROOFING OF CONCRETE DECK, AND REINFORCEMENT OF CONCRETE CASING OF STEEL GIRDERS OF CAROLINA AVE. SUBWAY

were coated with a bituminous composition. Nearly all this waterproofing work was done by the railway company.

The fill at the station site, between Carolina and Calhoun Aves., has a retaining-wall on either side. On the east, or Main St. side, this is a reinforced-concrete wall 15 ft. high, with counterforts. At the top this has a 4-ft. projection overhanging the sidewalk and carried by cantilever brackets, as shown in Fig. 7. The wall was built in sections 40 ft. long. No expansion filling was placed in the joints, but tarred paper and burlap were laid behind them to prevent leakage of water in the fill.

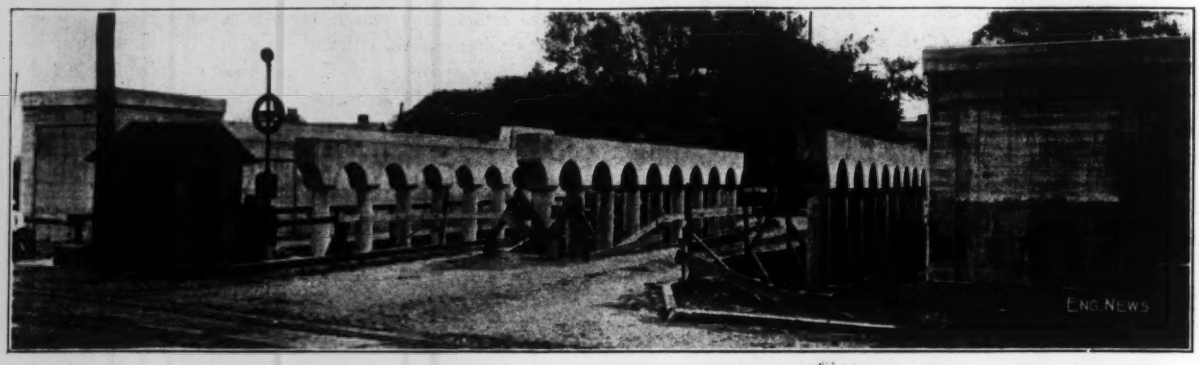

FIG. 5. CONCRETE ABUTMENTS AND BENTS FOR THE SOUTH FRONT ST. SUBWAY

On the west side is a heavy gravity retaining-wall along the driveway of the freighthouse (at the street level). This is shown in Fig. 8, which shows also the temporary track left in the driveway (but now removed) and the temporary platforms for the first tracks on the new elevation. The elevator tower beyond the platform shelter indicates the position of the station building. Similar walls (but without the cantilever slab on the reinforced walls) are used at other points. Near the Calhoun Ave. subway the retaining-wall is surmounted by an open-work parapet wall, having concrete panels cast separately and set in place.

The construction of the retaining-walls and subway

CONSTRUCTION WORK

The construction of the retaining-walls and subway bridges was hampered by the necessity of providing for traffic. There were about 60 trains daily, the heaviest traffic being from 7 a.m. to noon, and 3 to 5 p.m. The only freight movements over this part of the line were in switching service. The great difficulties encountered were the limited space available, the handling of concrete while keeping clear of trains, and the inability of the contractors to get certain parts of the site delivered to them for work at the time desired. For all the work (except at Carolina Ave.) the storage space for materials was very limited, and it was necessary to regulate shipments of all kinds so as to be able to use the material upon arrival.

The concrete was delivered in place by spouting from elevator towers, using self-supporting trussed chutes. Two stationary plants with 100-ft. towers and one portable plant with a 50-ft. tower were used, each of the former being set up twice (in different locations) and the latter being shifted as required. Each had its mixer, and in order to work to full capacity a two-compartment material bin or hopper was erected over the mixer, holding about 30 cu.yd. of stone and 15 cu.yd. of sand. The materials were brought in railway cars and unloaded direct to the mixer bin or to small storage piles, there being little room for storage. A derrick with clam-shell bucket took the material from the car or storage pile and dumped it into 1½-yd. cars which were hauled up a cable incline and dumped into the material hopper. The in-

FIG. 7. REINFORCED-CONCRETE RETAINING WALL (COUNTERFORT TYPE) WITH CANTILEVER SLAB FOR WALK

(Main St. side of new Central Station at Memphis, Tenn., Illinois Central R.R.)

located in the freighthouse driveway at Calhoun Ave., was kept open until Apr. 24, when it was put on the elevation. At the station this ran through the freighthouse driveway, at the foot of the retaining-wall on the west side of the station (Fig. 8). A temporary ticket office and other facilities were maintained at Calhoun St.

ENGINEERS AND CONTRACTORS

The design and construction of the whole work was under the direction of A. S. Baldwin, Chief Engineer of the Illinois Central R.R., and F. L. Thompson, Assistant Chief Engineer (then Engineer of Bridges and Buildings). F. R. Judd was assistant engineer in charge.

The retaining-walls and subways were built by the Bates & Rogers Construction Co., of Chicago, whose superintendent was R. Rasmussen. The station building was erected by the James Alexander Construction Co., of Memphis. All steelwork supporting the tracks and for the platform shelters and express building was erected by the Strobel Steel Construction Co., of Chicago. The power house, express building and the roofs of the platform shelters were built by Geo. B. Swift & Co., also of Chicago. The filling and track work, also the waterproofing of bridge floors, was all done by the railway company. The architects for the station were D. H. Burnham & Co., of Chicago, who made the design to conform to general plans and requirements submitted by the railway company.

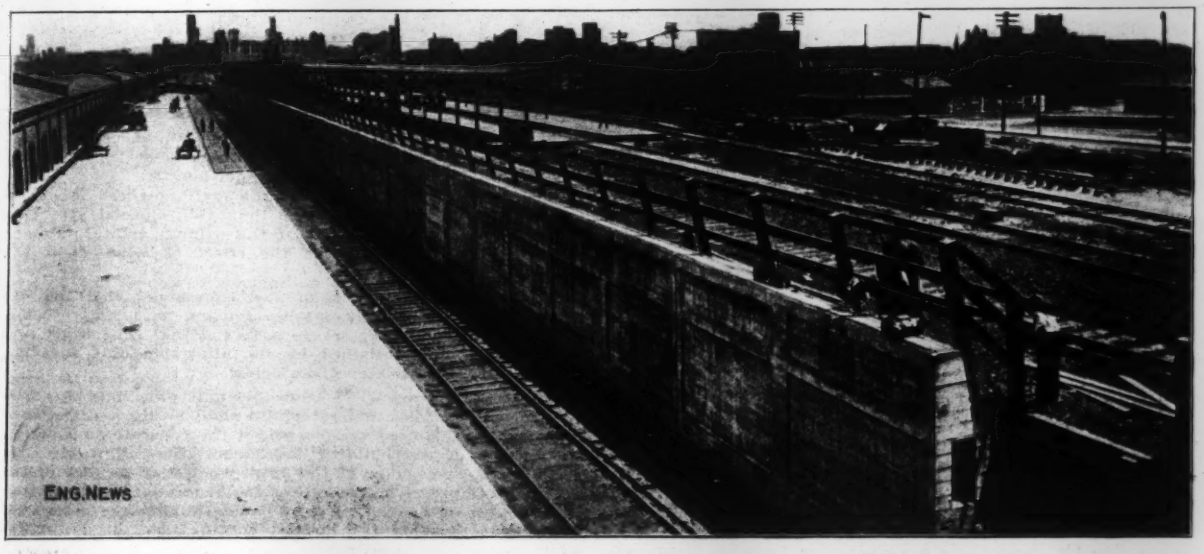

FIG. 8. CONCRETE RETAINING WALL (GRAVITY TYPE) AT THE NEW CENTRAL STATION AT MEMPHIS, TENN.

(At the left are the freight house and team driveway. The old running track at street level has now been removed. It was used during the elevation of the tracks.)

cline had a four-rail track in the lower portion and a three-rail track at the top.

Steel forms were used for the subway columns and arches. The concrete was made with stone and river sand. The proportions were 1:3:6 for gravity concrete, 1:2:4 for reinforced concrete and 1:1½:3 for the ornamental parapet panels, the 18-in. columns and the casing of steel girders.

The maximum output per day was about 550 yd. The entire elevation work, covering a distance of about 3000 ft., included about 30,000 yd. of concrete, 500 tons of reinforcing steel and 50,000 yd. of excavation. The crew varied from 100 to 600 men, depending upon the work that could be given to the contractors and the railway forces at one time.

One running track of the old line at street level, and

Is Public Office a Public Trust or a Private Snap?—The modern tendency among men who are trying to promote efficiency in the public service is to get the best man for the job—at home, if possible, otherwise abroad. And in every city where the new idea has taken hold there is the same shout to "keep the jobs at home."

It all depends upon the point of view. If the municipality is more interested in providing jobs for its home people than in developing efficient government, of course the proposition to hire out-of-town experts is wholly unjustifiable. But if efficient and satisfactory service is to be taken as the chief end of municipal government, it is quite obvious that when the right kind of a man is not available at home, he should be looked for wherever he is to be found—Cincinnati "Times-Star."

Reinforced-Concrete Flat-Slab Floors; New Chicago Building Ordinance

By J. Norman Jensen*

On Aug. 18, the Commissioner of Buildings of Chicago signed a ruling on the design and testing of reinforced-concrete flat-slab or girderless floor systems which is the result of nearly four years' study and testing. In the complication of methods of design prevalent for such systems, this one should prove both rational and simple.

In the early part of 1911, the necessity for a careful analysis and rational method of design of the flat-slab type of reinforced-concrete construction was felt in the Building Department. Plans showing the details of this recent advance in building construction were submitted to the department for approval, and it was desirable to have more information on the subject. In June, 1911, the Cantilever Flat Slab System controlled by the Concrete Steel Products Co., of Chicago, applied for a permit to use their type of construction. The Commissioner of Buildings, Henry Ericsson, appointed a commission of three engineers to investigate this system, and make a report recommending rational methods of design. This was the first flat-slab investigated.

From time to time other systems of flat-slab construction were reported on in the same way. In each case the report was made by a commission appointed as in the first case. The personnel was not always the same, but the greater proportion of the reports submitted bore the names of Prof. A. N. Talbot, of the University of Illinois, Prof. W. K. Hatt, of Purdue University, and Ernest McCullough, consulting engineer of Chicago.

Sources of Information

It is impossible to enumerate all the sources of information which were drawn upon in these reports, but a few typical ones will illustrate the thoroughness of these investigations. Whatever information obtained in the tests on reinforced-concrete footings made in the Engineering Experiment Station of the University of Illinois, which would have any bearing on the subject, was used. In some respects, the flat slab may be considered an inverted footing. The rubber panel tests conducted by the Corrugated Bar Co., and their extensometer tests in Minneapolis, Detroit, Niagara Falls and other cities were freely consulted. Theoretical analyses based on assumptions which appeared to be sound were also used insofar as they seemed applicable. The great source of information were extensometer tests on full size structures, such as the tests which were conducted on the Deere & Webber building in Minneapolis, the Curtis-Leger Fixture Co., A. J. Frank, Larkin, Schulz Baking Co., and other buildings in Chicago and elsewhere. Mention has been made that information was obtained from those engaged in the commercial side of the profession. Some belittle all information obtained from such sources. Those who are in a position to see the marvelous advances in building construction know that if it were not for the commercial interests there would be very little progress in the art of building.

By the middle of 1914, a great mass of information had accumulated in the office of the Chicago Building Department. Various tests had brought out certain facts which were not contemplated in the earlier reports. Using the accepted reports as a basis the department drew up a ruling in the following form:

THE DESIGN OF FLAT SLABS SHALL BE IN ACCORDANCE WITH THE FOLLOWING RULING

Definitions—Flat-slabs as understood by this ruling are reinforced-concrete slabs supported directly on reinforced-concrete columns with or without plates or capitals at the top, the whole construction being hingeless and monolithic without any visible beams or girders. The construction may be such as to admit the use of hollow panels in the ceiling or smooth ceiling with depressed panels in the floor.

The column capital shall be defined as the gradual flaring out of the top of the column without any marked offset.

The drop panel shall be defined as a square or rectangular depression around the column capital extending below the slab adjacent to it.

The panel length shall be defined as the distance center to center of columns of the side of a square panel, or the average distance center to center of columns of the long and short sides of a rectangular panel.

Columns—The least dimension of any concrete column shall be not less than one-twelfth the panel length, or one-twelfth the clear height of the column.

Slab Thickness—The minimum total thickness of the slab in inches shall be determined by the formula:

$$t = 0.023\, L \sqrt{w}$$

In the formula hereinabove given,

t = Total thickness of slab in in.;

L = Panel length in ft.;

w = Total live and dead load in lb. per sq.ft.

In no case shall the slab thickness be less than one-thirty-secondth of the panel length for floors, and one-fortieth of the panel length for roofs, and also not less than 6 in.

Column Capital—The diameter of the column capital shall be measured where its vertical thickness is at least 1½ in., and shall be at least 0.225 of the panel length.

The slope of the column capital shall nowhere make an angle with the vertical of more than 45°. Special attention shall be given to the design of the column capital in considering eccentric loads, and the effect of wind upon the structure.

Drop Panel—The depth of the drop panel shall be determined by computing it as a beam, using the negative bending moment specified elsewhere in this ruling. The width and length shall be determined by the allowable unit shearing stresses on the perimeter given below.

Shearing Stresses—The allowable unit punching shear on the perimeter of the column capital shall be three-fiftieths of the ultimate compressive strength of the concrete as given in section 546 of the building ordinance. The allowable unit shear on the perimeter of the drop panel shall be 0.03 of the ultimate compressive strength of the concrete. In computing shearing stress for the purpose of determining the resistance to diagonal tension the method specified by the ordinance shall be used.

Panel Strips—For purposes of establishing the bending moments and the resisting moments of a square panel, the panel shall be divided into strips known as strip A and strip B. Strip A shall include the reinforcement and slab in a width extending from the center line of the columns for a distance each side of this center line equal to one-quarter of the panel length. Strip B shall include the reinforcement and slab in the half width remaining in the center of the panel. At right angles to these strips, the panel shall be divided into similar strips A and B, having the same widths and relations to the center line of the columns as the above strips. These strips shall be for designing purposes only, and are not intended as the boundary lines of any bands of steel used.

These strips shall apply to the system of reinforcement in which the reinforcing bars are placed parallel and at right angles to the center line of the columns, hereinafter known as the two-way system and also to the system of reinforcement in which the reinforcing bars are placed parallel, at right angles to and diagonal to the center line of the columns hereinafter known as the four-way system.

Bending Moment Coefficients, Interior Panel, Two-Way System—The negative bending moment taken at a cross-section of each strip A at the edge of a column capital or over it, shall be taken as $WL^2/15$. The positive bending moment taken at a cross-section of each strip A, midway between column centers shall be taken as $WL^2/30$. The positive bending

*Architectural Engineer, Department of Buildings, Chicago, Ill.

moment taken at a cross-section of each strip B in the middle of the panel shall be taken at $WL^2/60$. The negative bending moment taken at a cross-section of each strip B on the center line of the column shall be taken at $WL^2/60$. In the formulas hereinabove given

W = Total live and dead load per lin.ft. of each strip,

L = Panel length in ft.

Bending Moment Coefficients, Interior Panel, Four-Way System—The negative bending moment taken at a cross-section of each strip A at the edge of the column capital or over it, shall be taken as $WL^2/15$. The positive bending moment taken at a cross-section of each strip A, midway between column centers shall be taken as $WL^2/40$. The positive bending moment taken at a cross-section of each strip B in the middle of the panel shall be taken at $WL^2/60$. The negative bending moment taken at a cross-section of each strip B on the center line of the column shall be taken at $WL^2/60$.

Bending Moment Coefficients, Wall Panels—Wherever the coefficients $1/15$, $1/30$, $1/40$ or $1/60$ appear in the moments given for interior panels in either the two-way or the four-way systems, the coefficients $1/12$, $1/25$, $1/33$ and $1/50$, respectively, shall be used in the moments for wall panels supported on concrete columns and girders.

When brick walls are used to partly support wall panels, these walls shall be stiffened by pilasters or piers as directed by the Commissioner of Buildings. Wherever the coefficients $1/15$, $1/30$, $1/40$ or $1/60$ appear in the moments given for interior panels in either the two-way or the four-way systems, the coefficients $1/10$, $1/20$, $1/27$ and $1/40$, respectively, shall be used in the moments for such panels resting on brick walls.

Point of Inflection—For the purpose of making the calculations of the bending moment at the sections away from the column capital, the point of inflection shall be considered as being one-quarter the distance center to center of columns, both crosswise and diagonally, from the center of the column.

The Tensile Stress in Steel and Compressive Stress in Concrete—The tensile stress in steel and the compressive stress in the concrete to resist the bending moment shall be calculated on the basis of the reinforcement and slab in the width included in a given strip, and according to the assumptions and requirements given in sections 545 to 548, inclusive, of the building ordinance.*

The steel shall be considered as being concentrated at the center of gravity of all the bands of steel in a given strip.

For the four-way system of reinforcement, the amount of steel to resist the negative bending moment over the support in each strip A shall be taken as the sum of the areas of steel in one cross band and one diagonal band. The amount of steel to resist the positive bending moment of each strip B shall be considered as the area of the steel in a diagonal band. The amount of steel to resist the positive bending moment in each strip A shall be considered as the area of the steel in a crossband, and the amount of steel to resist the negative moment in each strip B shall be the steel included in the width of strip B.

For the two-way system of reinforcement, the amount of steel to resist the bending moment in any stirp that shall be considered as the area of steel included in the width of the strip.

In both systems of reinforcement the compressive stress in the concrete in any strip shall be calculated by taking the area of steel considered for each strip and applying it in a beam formula based on the principles of Sect. 548 of the building ordinance.

Rectangular Panels—When the length of a panel does not exceed the breadth by more than 5%, all computations shall be made on the basis of a square with sides equal to the mean of the length and breadth. In no rectangular panel shall the length exceed four-thirds the breadth.

For panels with length more than 5% in excess of the breadth, the slab shall first be designated for a bending moment based on an assumed square panel with sides equal to the mean of the length and breadth of the rectangular panel.

For the four-way system of reinforcement, the amount of steel found for the positive moment of each strip B by designing in this manner shall be that used in the diagonal band. For the positive moment in each strip A, the required amount of steel in the crossband shall be obtained by multiplying the steel used in the design of the assumed square panel by the cube of the ratio found by dividing the length or breadth of the rectangular panel by the side of the assumed square panel, for the long and short sides of the panel, respectively. The compressive stresses shall be calculated on the basis of a width equal to one-half of the side of the assumed square panel, and on the assumptions used in the calculations of compressive stresses in square panels. In no case shall the amount of steel in the short side be less than two-thirds of that required for the long side.

For the two-way system of reinforcement, the amount of steel found for the positive and negative moment of each strip B by designing in this manner shall be obtained by multiplying the steel used in the design of the assumed square panel by the cube of the ratio found by dividing the length or breadth of the rectangular panel by the side of the assumed square panel, for the short and long sides of the panel, respectively. The method of obtaining the amount of steel required for each strip A shall be the same as that given above for the four-way system.

Walls and Openings—Girders or beams shall be constructed under walls and around openings, and to carry concentrated loads.

Computations—Complete computations of interior and wall panels and such other portions of the building as may be required by the Commissioners of Buildings shall be left in the office of the Commissioner of Buildings when plans are presented for approval.

Placing of Steel—In order that the slab bars shall be maintained in the position shown in the design during the work of pouring the slab, spacers and supports shall be provided satisfactory to the Commissioner of Buildings. All bars shall be secured in place at intersections by wire or other metal fastenings. In no case shall the spacing of the bars exceed 9 in. The steel to resist the negative moment in each strip B shall extend one-quarter of the panel length beyond the center line of the columns in both directions.

All splices in bars shall be made over the column head. The length of the splice beyond the center line of the column in both directions shall be at least 2 ft., nor less than that necessary for the full development of the strength of the bar as limited by the unit bond stresses given by the ordinance. The splicing of adjacent bars shall be avoided as far as possible.

Slab bars which are lapped over the column, the sectional area of both being included in the calculations for negative moment, shall extend not less than 0.25 of the panel length for crossbands, and 0.35 of the panel length for diagonal bands, beyond the column center.

Test of Workmanship—The Commissioner of Buildings or his representative may choose any two adjacent panels in the building for the purpose of ascertaining the character of workmanship. The test shall not be made sooner than the time required for the cement to set thoroughly, nor less than six weeks after the concrete had been poured.

All deflections under test load shall be taken at the center of the slab, and shall be measured from the normal unloaded position of the slab. The two panels selected shall be uniformly loaded over their entire area with a load equal to the dead load plus twice the live load, thus obtaining twice the total design load. The load shall remain in place not less than 24 hr. If the total deflection in the center of the panel under the test load does not exceed $1/800$ of the panel length, the slab may be placarded to carry the full design live load. If it exceeds this amount of deflection, and recovers not less

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*Footnote herewith gives unit stresses allowable.

546. **Ratio of Moduli of Elasticity—Adhesion—Bond.** (a) The calculations for the strength of reinforced concrete shall be based on the assumed ultimate compressive strength per square inch designated by the letter "U" given in the table below for the mixture to be used.

(b) The ratio designated by the letter "R" of the modulus of elasticity of steel to that of the different grades of concrete shall be taken in accordance with the following table:

	U	R
1 cement, 1 sand, 2 broken stone, gravel or slag..	2900	10
1 cement, 1½ sand, 3 broken stone, gravel or slag	2400	12
1 cement, 2 sand, 4 broken stone, gravel or slag..	2000	15

547. **Unit Stresses for Steel and Concrete.** (a) The stresses in the concrete and the steel shall not exceed the following limits:

(b) Tensile stress in steel shall not exceed one-third of its elastic limits and shall not exceed 18,000 lb. per sq.in.

(c) Direct compression in concrete shall be one-fifth of its ultimate strength. Bending in extreme fiber of concrete shall be 0.35 of the ultimate strength.

(f) Tension in concrete on diagonal plane shall be one-fiftieth of the ultimate compressive strength.

(g) For a concrete composed of one part of cement, two parts of sand and four parts of broken stone, the allowable unit stress for adhesion per square inch of surface of imbedment shall not exceed the following:

	Pounds per sq.in.
On plain round or square bars of structural steel.....	70
On plain round or square bars of high-carbon steel...	50
On plain flat bars, in which the ratio of the sides is not more than 2 to 1.....	50
On twisted bars when the twisting is not less than one complete twist in eight diameters.....	100

than 80% of the total deflection within seven days after the load is removed, the slab may be placarded to carry the full design live load. If the deflection exceeds the allowable amount above specified, and the recovery is less than 80% in seven days after the removal of the test load, other tests shall be made on the same or other panels, the results of which will determine the amount of live load the slabs will be permitted to carry.

General—The design and execution of the work shall conform to the provisions of the Chicago building ordinances and to correct principles of construction.

Discussion of Ruling

Certain phases of this ruling may require further explanation. Fig. 1 shows a plan and section of a typical interior panel contemplated in the ruling. The general arrangement of steel is not shown, as it varies somewhat with the ideas of the designers. As a rule, the reinforcement consists of belts of steel placed on rectangular and diagonal lines with respect to the center line of the column. In the middle of the panel, the steel is in the bottom. Over the column heads and at right angles to the rectangular bands, most of the steel is in the top of the slab.

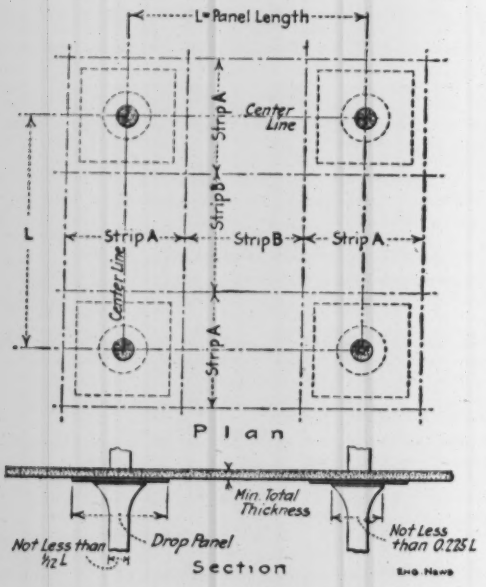


Fig. 1. Typical Flat-Slab Floor as Described in New Chicago Building Ruling

As a preliminary step, it was necessary to define the terms used. The next step was the determination of the minimum width of the column. Test after test has shown that the columns bend, and that the stresses on the extreme fiber of the column may be even greater than in the slab itself. So it is that the column is an essential part of the whole construction, and they should not be too narrow in any flat-slab design.

The thickness of the slab has been a much disputed point. This thickness should be a function of both the span and the load, so the formula given was adopted. The formula controls for heavy loads, and the other requirements for light loads.

The minimum diameter of the column capital is given because the capital performs a valuable function in stiffening the entire construction, and also because the bending moments given were based on such a width. The function of the drop panel is to provide a greater depth for negative moment for the slab, and also to provide additional concrete for shear.

Referring to Fig. 1, it will be seen that the slab is divided into imaginary strips A and B as defined in the ruling. In any slab, the bending moment varies from point to point, being least in the middle and increasing as the center line of the columns is approached. To be strictly correct, therefore, the slab should be divided into a great many strips so that the values for these varying moments could be expressed. For practical reasons, the slab was divided into the two strips shown.

Although the spacing of the steel may vary within the width of the strip to resist the varying bending moment, still these strips are a convenient way of expressing the bending moment for the full width of the strip. The product WL, appearing in the formulas used for each strip, is really one-half the total load on the whole panel measuring center to center of columns, as it will be seen by inspection of Fig. 1 that $W = wL/2$, where w is the total live- and dead-load in lb. per sq.ft.

The bending moment for the middle of the panel seems very small. When one considers that the flat slab is essentially a cantilever, the moment does not seem so strange. It will also be noticed that the same bending moment is given for the strip at right angles to strip A, on the center line of the columns. The cracking in the top of the slab and various tests have shown that tensile stresses exist in this part of the slab, and for that reason a small amount of steel is required to take care of these stresses.

For the same span and load more steel or concrete or both are required in wall panels than in interior panels. The coefficients for panels supported on brick walls are given in the ruling. The reasons for the larger moments for the latter support is the fact that a brick wall is a poor type of construction to take the bending that usually exists in columns carrying flat slabs. The results of some flat-slab jobs resting on brick wall are not as satisfactory as they might have been.

The subject of the point of inflection has been an open argument for some time. The results of tests are not entirely concordant, but the method used represents good practice.

As far as the ruling is concerned, the flat-slab is a beam, and nothing else. Knowing the moments and loads, the design resolves itself into ordinary reinforced-concrete design. The tensile stress in the steel and the compressive stress in the concrete can be computed on that basis.

The distribution of load in rectangular panels is given by some authorities as a function of the fourth power of the span, and by others as a function of the cube. The method of the cubes given by the ruling represents the present knowledge on this subject.

No matter how carefully a slab is designed, if no provision is made to keep the steel in the position where it belongs, the design is valueless. There are a great many ways of accomplishing this purpose, but especial attention must be paid to the steel over the column capital.

While the ruling states that splices should be made over the column head, still all the laps should not be in a line. Such an arrangement would create a plane of weakness, and for this reason it is advisable to distribute the laps so as to occur at different column capitals.

After the work is up it is required to be tested. The

TABLE GIVING TEST DATA. REINFORCED CONCRETE FLAT SLABS IN CHICAGO

No.	Name of Building	Age of concrete weeks	Drop panel size	Total thk. slab in.	Load per sq.ft. Lbs. design	Load per sq.ft. Lbs. test	Size of panel b	Size of panel l	Total Deflection, 100 in. A	B	C	D	E	F	G	H	I
1	Lyon & Healy	21	7′ 0″	7½	150	400	21′ 0″	18′ 6″	14	36	35	36	18	4	5	6	5
2	Illinois Wall Paper Mills	11	4′ 6″	8½	200	506	16′ 0″	21′ 0″	8	28	19	29	8	14	13	14	14
3	Edward Katzinger	12	6′ 0″	8	350	830	14′ 11″	15′ 5″	4	13	10	11	2	1	4	4	4
4	Sears, Roebuck & Co.	9	4′ 0″	8	200	500	18′ 0″	18′ 0″	16	44	40	40	11	10	12	14	13
5	Adam Schaaf Piano Co.	13	4′ 0″	8	200	525	18′ 0″	18′ 0″	7	35	26	32	12	8	12	10	10
6	Hollander Express & Van Co.	14	4′ 6″	6½	150	400	15′ 0″	12′ 7″	6	17	13	19		1	8	5	1
7	American Book Co.	13	4′ 6″	10	300	740	19′ 5″	19′ 3½″	7	30	26	28	10	4	5	5	4
8	International Register Co.	10	4′ 0″	7½	150	400	18′ 6′	17′ 10″	19	47	30	40	13	10	10	16	11
9	R. R. Donnelly	13	9′ 0″	11	300	750	24′ 4″	24′ 10″	8	32	8				12	8	
10	Ford Motor Co.	11	7′ 0″	11	150	420	28′ 0″	25′ 0″	11	37	17				6	8	

deflection is used as a measure of the workmanship. It has been found by experience that the deflection requirement as given is not excessive, as any well designed and carefully built job will test to comply with this portion of the ruling, if the concrete has had a sufficient time to set.

All buildings used for the manufacture and storage of goods in the City of Chicago are required to be placarded. Each floor of each such building is required to have a card on which is stated the safe live-load per square foot to which the floor can be loaded. These cards are prepared by engineers and architects, and if correct, are

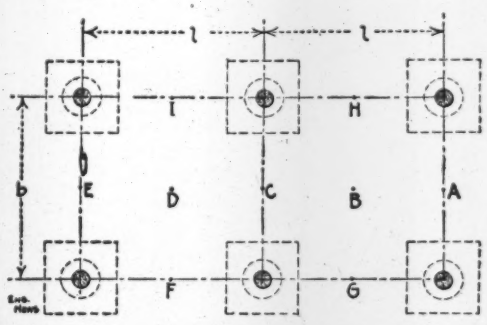


FIG. 2. DIAGRAM SHOWING LOCATION OF DEFLECTION MEASUREMENTS IN CHICAGO BUILDING TESTS OF FLAT-SLAB FLOORS

approved with the official stamp of the Commissioner of Buildings. In case the design is correct, but the workmanship poor, the department has a means of preventing the loading of the floor to its full designed capacity.

RESULTS OF TESTS

No matter how carefully a ruling may be drawn up, verification of such a ruling is desirable. During the last three years, 60 buildings designed in general in accordance with the ruling given above have been built. None of the buildings were more than six stories in height, but some of them covered great areas of ground.

In the accompanying table is given the results of the tests of ten buildings taken at random from the records of the department. None of these are extensometer tests. On the left-hand side of the table is given general data in regard to the panel. The total thickness of slab refers to the thickness in the middle of the panel. The designing and tests loads are given in lb. per sq.ft.

The location of the points used in measuring the deflection is given in Fig. 2. This same general method of lettering the points was maintained throughout. On the right of the table is given the total deflections of these points in $^1/_{100}$ in.

The readings of deflection were taken with great care. In some cases light poles were hung from the ceiling of the panels tested from the points shown. On these poles were glued paper targets, which were read with an engineer's level. In such cases, readings were also taken on fixed points on the columns, as there was usually a small settlement in these columns when under load. The readings thus obtained were corrected for the settlement, the corrected readings being the ones appearing in the table. Sometimes other methods were used such as fixing points in the floor and the ceiling, and reading the distances between these points with great precision. Multiplying levers were occasionally used.

It will be observed that the table covers a wide range, the test load varying from about 400 to 800 lb., and the span from 15 to 28 ft. Inspection of this table shows in some cases that points under identical conditions had the same deflection while in other cases there was a wide discrepancy. As a general rule, there was a very close agreement between the deflections of the center of the two adjoining panels.

Tests No. 4 and 5 bring out the fact that the deflection is a function of the age of the concrete. In these two buildings the conditions were identical in that the size of the panel, design, method of reinforcement, supervision and contractors were the same in both. The last two tests were on single panels as the size of the panels and the tests loads were so large that a double-panel test was waived. All the ten tests complied with the test of workmanship given above.

The statement is sometimes made that under continuous load a flat-slab panel would become fatigued, and ultimately break down. In order to determine whether there is any changes in stress or not, the department has required that a panel be tested with the test load continuously for one year. This extensometer test is under the direction of A. R. Lord, consulting engineer of Chicago, who has taken preliminary readings, and will take readings at regular intervals throughout the year.

CONCLUSION

The ruling as given above may not be theoretically correct according to the conception of some. It may be decidedly empirical. Information obtained in the future may necessitate a revision in some parts of the ruling. With the information available to date, however, it is known that designs prepared in accordance with this ruling will be safe, and that buildings constructed in accordance with the design in a workmanlike manner will abundantly carry the loads for which they were designed.

The Production of Natural Gas in the United States in 1913 surpassed that of any previous year in both quantity and value. Total gas production in 1913 is estimated at 581,898,239,000 cu.ft., valued at $87,847,000, an average price of 15.10c. per M. cu.ft., an increase of 19,797,787,000 cu.ft. and $3,282,720 in value over 1912. Of this total product, about 32% was utilized for domestic and 68% was utilized for industrial purposes.

West Virginia led in 1913 in quantity produced. Pennsylvania was second. Pennsylvania led in quantity consumed, and Ohio was second.—U. S. Geological Survey.

Winter Construction of a Reinforced-Concrete Building

It is not so long since contractors hesitated to undertake extensive reinforced-concrete construction in the low temperatures of winter because of the fear that the concrete could not be sufficiently protected against freezing. Under the most modern conditions of construction, however, and with proper precautions, it is now quite possible to build concrete buildings in the winter time of precisely as stable a structure as in the summer. Such a construction was completed during the past winter in the erection of the concrete factory building for the New York Consolidated Card Co., at 12th St. and Webster Ave., Long Island City, in the City of New York.

This building is five stories high and covers in plan an area of 70x450 ft., in addition to the various extensions for power house, garage and outside stairwells. The plan called for about 10,000 cu.yd. of excavation at the south end of the building, so when construction was started last fall it was decided to push the north end with all possible haste in order that a part of the building might be completely roofed over before extremely cold weather set in. Therefore, excavation for the footings at the north end was started on Oct. 21, 1913, and the roof placed at that end of the building on Dec. 23, 1913. Construction on the south end started Nov. 26, 1914, and the roof was completed Jan. 30, 1914. For the five months from November, 1913, to March, 1914, the range of temperature at New York City was as shown in the following table. It will be seen that particularly in January and February, when the south end of the building was under construction, extremely cold weather prevailed:

TEMPERATURES IN DEGREES FAHRENHEIT IN NEW YORK CITY, NOVEMBER, 1913-MARCH, 1914

	Nov.	Dec.	Jan.	Feb.	Mar.
Mean	46.9	38.8	31.4	25.3	35.8
Maximum	70	58	58	52	70
Minimum	28	19	—5	—2	14

While construction for the north end of the building was going on, materials were ordered shipped and received and stored in the vicinity of the mixing plant, which was located on the center of the north part of the building. In this way, there was stored enough sand and gravel inside the building to complete the job, and at one time 36,000 bags of cement were stored, covered with tarpaulin, ready for use. This precaution insured the quick completion of the job independent of slow winter delivery. Inside of the completed part were installed arrangements for heating the sand and gravel, water barrel, steel reinforcement and the forms.

FIG. 1. TARPAULINS OVER WALL OPENINGS DURING WINTER CONCRETING, NEW YORK CONSOLIDATED CARD CO. BUILDING, LONG ISLAND CITY

The precautions taken comprised the heating of the sand and gravel on griddles of steam coils, connecting the water barrel to a steam jet and running a steam pipe to the working floor, so that the reinforcing rods could be sprayed with steam immediately before placing to prevent any ice particles adhering thereto. Then each floor, immediately after concreting, was completely surrounded by tarpaulins, above and on the outside, and salamanders (open stoves burning coke) were placed on the floor beneath, and holes left in the floor forms to allow the heat to find its way up to the floor.

The three accompanying photographs show various views of the concreting work in the cold weather. Fig. 1 shows the tarpaulin hung over the side of the building and fastened, completely inclosing the portion of the structure to be concreted. This precaution was necessary to protect the columns and to hold the heat for the pro-

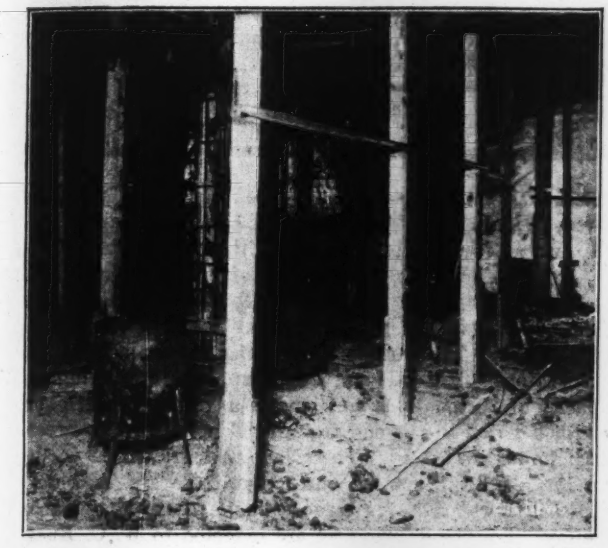


FIG. 2. INTERIOR OF BUILDING, SHOWING SALAMANDERS HEATING NEW CONCRETE FLOOR ABOVE

tection of the floor above. Fig. 2 shows the interior of the same floor with the tarpaulin on the outside wall and the salamanders, one of which was placed for every 300 sq.ft. of floor area, in action heating up the floor in the wooden tower. Forms were made up for about 75% of the building, this work being greatly facilitated by the use of a small circular saw run by a 5-hp. motor.

In hoisting steel and material to the working floor, a tower similar to the concrete tower was used and located at the side of the building with one leg of the tower equipped with a derrick. The advantage of the tower over the derrick mounted on the working floor is that construction of part of the floor does not have to be held up while erecting and handling material. For pulling and setting forms, a small A-frame equipped with block and tackle was used. Stone was dumped in the depressed bins in the street, from which it fed by gravity to a bucket conveyor, and by this means was deposited to the center of the building adjacent to the mixing plant, thereby greatly reducing the cost of its handling. All of these conveyors and hoists were operated by electricity.

To insure the heating of the material, 765,000 lb. of coke, 50,000 sq.ft. of canvas and 71 salamanders were used in the construction of the building. The contractor states that there was a slight increased cost for the winter weather construction over summer weather construction, but that a complete and careful organization served to offset some of this extra cost, and the increased profit due to earlier completion should be taken into consideration.

Ballinger & Perrot, Philadelphia and New York, were the architects and engineers for the building, and the Turner Construction Co., of New York City, the general contractor. To the latter was due the method of winter construction described above.

FIG. 3. TARPAULINS COVERING FLOOR JUST LAID, JAN. 16, 1914

(Minimum temperature record: Jan. 13, 5°; Jan. 14, 5°; Jan. 15, 15°; Jan. 16, 29°.)

inclosure. Fig. 3 shows a view of a finished floor with the tarpaulin, which was hung on scantlings 12 in. above the floor, immediately after the placing of the concrete.

For the construction of the building only one mixing plant was used. This plant was located about in the center of the north end of the building, which made it necessary to leave a small opening in each floor in which to operate the hoist. The mixer was sunk about 5 ft. below the first floor level, thereby making a charging operation merely one of dumping and not of pushing a heavy load up an incline. The mixer was run by a small motor, which also operated an automatic dumping bucket

Production of Slate in the United States, in 1913, was valued at $6,175,456, an increase over 1912 of $132,158, or 2.19%. This advance, according to A. T. Coons, of the U. S. Geological Survey, was caused by an increase in the average price and not due to increased production. The average price per square (100 sq.ft.) of roofing slate has fluctuated but little in the past 10 years; it was $3.78 in 1904, $3.87 in 1912, and $4 in 1913. About 72% of the 1913 figure was for roofing slate.

Field and Office

Contractor's Scows for the Fraser River

In the construction of the Grand Trunk Pacific Ry. along the Fraser River, in British Columbia, the river afforded the only means of transportation for distributing plant and material to different points at which work was to be commenced. This was a dangerous service, as at high water (the only navigable condition) the river has a swift surrent with numerous eddies and rapids. From Tete Jaune Cache some of the material was carried in mall stern-wheel river steamers built for the work by

FIG. 1. FREIGHTING CONTRACTOR'S PLANT AND SUPPLIES BY SCOWS ON THE FRASER RIVER; GRAND TRUNK PACIFIC RY.

(A rock at this point, located just to the left of the boat in the position shown, caused numerous accidents as the current tended to throw the scows against it.)

Foley, Welch & Stewart (of Winnipeg), contractors for the grading. But the great bulk of the machinery, material and supplies was transported in large scows, carried down by the current, and controlled by a long oar or sweep at each end. Steam shovels, dump cars, cement,

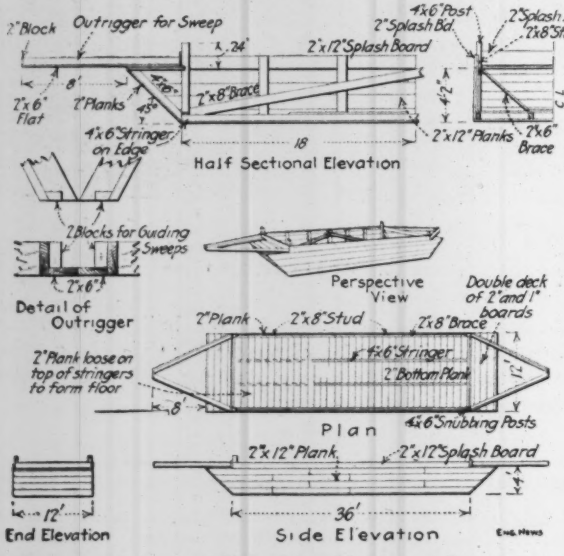


FIG. 2. SCOW FOR FLOATING MATERIAL DOWN THE FRASER RIVER FOR THE BATES & ROGERS CONSTRUCTION CO.

steel sheet piling, food supplies, etc., were handled in this way, and freighted for distances of 150 to 300 miles. Fig. 1 gives an idea of the character of this transportation.

Fig. 2 shows the construction of the scow, of which over 200 were built by the Bates & Rogers Construction Co. (of Chicago), contractors for all the bridge substructure work. The hull is 36 ft. long on the bottom, 44 ft. on top, 12 ft. wide and 4 ft. deep, with a carrying capacity of 20 tons. At each end is a V-shaped outrigger, with a notch in the end forming a guide for the sweep. All joints are calked. The sides can be raised 12 in. by a line of 12-in. splash boards, but these are used only in rough water or for cargoes liable to be damaged by spray. For the drawing we are indebted to W. C. Ruegnitz, Superintendent for the Bates & Rogers Construction Co.

A Few Motor-Truck Novelties for Contractors

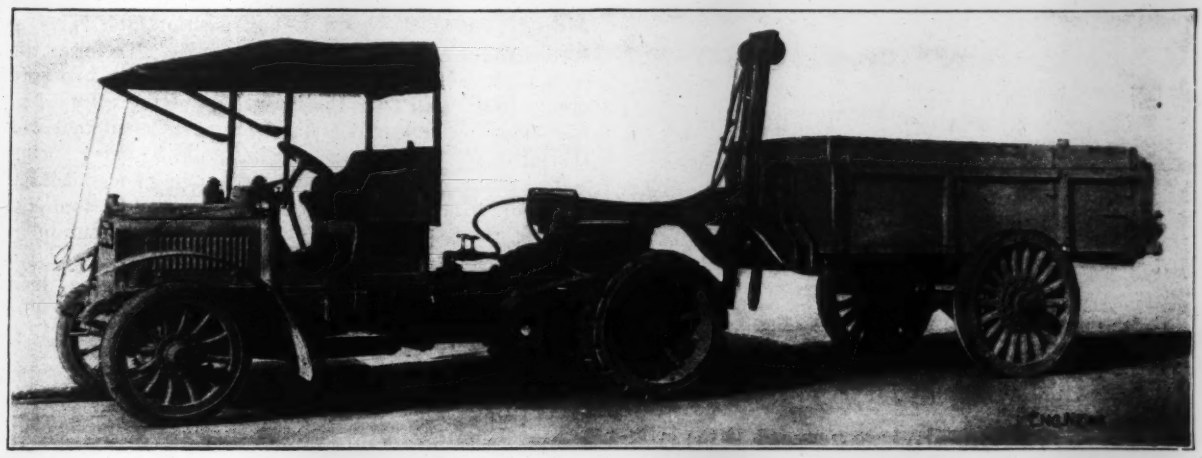
A TRACTOR-TRAILER OUTFIT FOR CARRYING HOT ASPHALT

An interesting and novel motor vehicle, in use by the Borough Asphalt Co., Brooklyn, New York, is shown in the accompanying figure. It is a truck with trailer body of 5-ton (100-cu.ft.) capacity equipped with a hydraulic-hoist dump. Such trailer outfits are claimed to give greater flexibility of operation, permitting heavy loads to be handled in rough service where an ordinary truck could not pull out. In this case, the trailer body is of wood, 10½ ft. long, 4½ ft. wide at the front, 5 ft. wide at the rear and 2 ft. high. There is a sheet-steel lining, laid over ½ in. of asbestos board and made tight for carrying hot asphalt-pavement materials—though it should be as serviceable as any truck for hauling sand and gravel.

The body dumps at the rear end—being raised through 45° by mechanism controlled from the driver's seat. The tilting device comprises a cylinder and piston on the trailer and an oil pump on the tractor, with hose connections. The pump is driven from the main shaft by sprocket and chain with a disengaging clutch. Oil is forced into the bottom of the cylinder under pressures up to 800 lb. per sq.in. On the piston rod at its exposed end is a crosshead and this in turn carries a pair of sheaves over each of which runs a cable connecting a lifting arm on the front of the body to an equalizing bar on the trailer frame. A pipe leading to the pump suction connects with a cylinder port near the upper end and when the limit of travel is reached, pressure under the piston is relieved through this. The return is by gravity, valves at the pump allowing the oil to flow in reverse direction from beneath the piston.

The connection between truck and trailer is by a peculiar universal joint. A flat steel ring is fastened to the rear of the truck frame. This supports in a recess the lower half of the universal joint, allowing free horizontal

rotation of it. A long, horizontal pin is held in heavy trunnions on the lower half and engages, at right angles, a removable horizontal pin which passes through the trunnions of the inverted third or upper part of the joint. This last further bears a toothed plate engaging with a duplicate on the trailer frame but easily disengaged by pulling a horizontal bolt. A couple of spiral springs between the upper and lower parts of the joint stiffen it against sidewise rocking. The tractor and trailer shown (Saurer type) were made by the International Motor Co., New York City; the dumping hoist was made by the Wood Hydraulic Hoist Co., St. Paul, Minn.

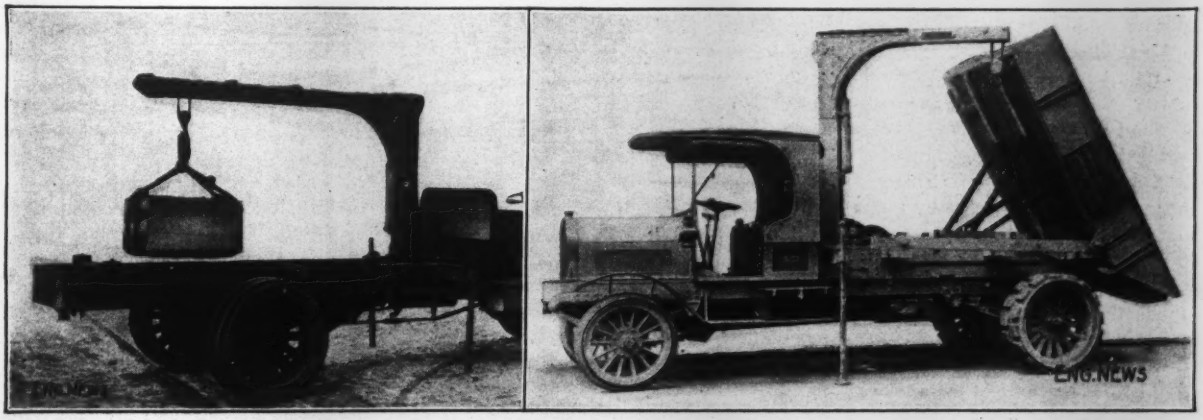


A Tractor-Trailer Outfit for Hot Asphalt

A Crane for Motor Trucks

The wider use of heavy motor tracks has brought an increasing number of instances of trouble in unloading at destinations where there is no particular handling equipment. To meet this difficulty, in some cases special cranes have been installed on the truck chassis, one example (used by the Pullman Co., at Chicago) being shown at the left in the accompanying figure—a pillar-and-jib crane of one ton capacity. A structural-steel mast with jib rotates (on a roller thrust bearing) about a steel casting bolted to the chassis frame. A vertical hoist shaft extends from the head of the pillar through the chassis and is geared to a horizontal shaft below. This last in turn is driven through chains and sprockets (and an idler shaft to reduce speed) from the main transmission. The horizontal hoisting shaft has a double jaw clutch worked by raising or lowering a lever behind the driver's seat; this throws one or the other of two bevel gears into mesh with a gear on the vertical shaft, according as the crane has to hoist or lower. This vertical shaft is bevelgeared to a short horizontal shaft, at the top of the pillar, bearing a chain sprocket, over which the dead-ended hoist chain passes. The cylinder on the mast holds the excess length of chain when the hook is up. The jib arm is formed by two channels with flanges turned in. The crane trolley, running on the bottom flanges, is moved in and out by a hand chain and sprocket. Swinging is done by hand. Outrigger supports, made of iron pipe, are provided to prevent overturning the truck, and the chassis is reinforced by a steel top frame. The outfit shown was built by the Brown Hoisting Machinery Co., and the Peerless Motor Co., of Cleveland.

The 7½-ton dumping truck with crane shown at the right was recently delivered to the Bureau of Sewers, Borough of the Bronx, New York City. It was intended to facilitate hoisting sediment from sewer manholes and loading it, which work has previously been done by hand or with a small tripod derrick. The crane has a capacity of 1½ tons; the body is water-tight and has a capacity of 3½ cu.yd. The dumping is at the rear end, the body being raised through 60° angle by a hand hoist, the



A Power Crane for Motor Trucks

latter an arrangement of arms, cables, drum and gears. The body is lowered by gravity and is controlled by a hand brake on the drum. The truck is a Mack type made by the International Motor Co., New York.

The Hydraulic Hoist on Motor Trucks*

The modern hydraulic hoist for dumping motor trucks, in which a rotary oil pump is mounted with hoist cyl-

Hydraulic Motor-Truck Hoist in Operation, (July, 1914)

inder carrying the oil reservoir in the head of the cylinder, was successfully applied by the Pierce-Arrow Motor Co., Buffalo, N. Y., in August, 1912. The pump is started by lifting a lever located in front of the cab seat. A three-way valve is provided for raising or lowering the hoist. Experience has shown that it is best that the driver get down from the seat to operate the valve, or that his helper operates it, as it is safer and more satisfactory to see exactly where the load is dumped. This cannot be accomplished from the driver's seat as the trunk body obscures the view. Fig. 1 shows the details of the hoist and its arrangement on the truck chasis.

The pump is operated through chain sprockets, one situated in front of the cab and another behind. The sprocket at the back of the driver's seat, which connects through a chain directly to the pump, makes a maximum of 620 r.p.m. and is controlled by a governor on the motor. The pump itself turns at 800 r.p.m.

The hydraulic cylinder is made from weldless steel tubing, machined and gun reamed to a bore of 5 in. The end flanges are screwed on and a seal of iron (melted by blast flame) run in a groove between the flange and the tube, preventing any leakage. The joint at the head and base is made oiltight by a copper gasket, as shown in Fig. 2. The piston rod is of nickel-steel 1⅝ in. in diameter.

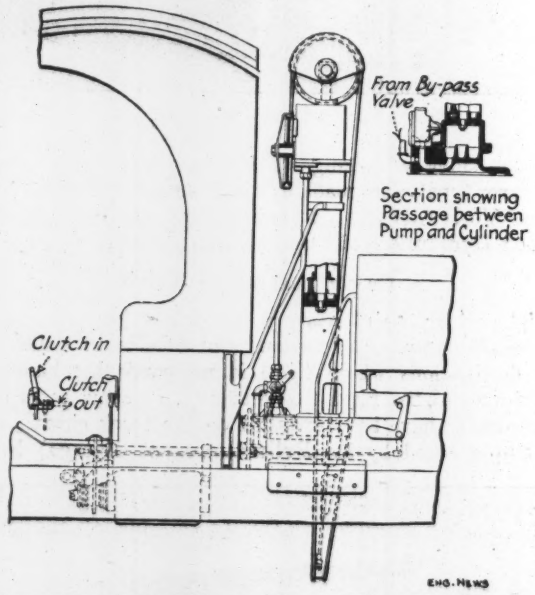
The piston has the usual cup leather. In earlier stages of the development, grooves were cut in the top of the cylinder, so that when the piston reached the limit of its travel the oil bypassed along these grooves. This was found to wear the leather and was abandoned in favor of the present method wherein three small valves in the piston open when in contact with a spacer. By this means the travel of the body can be readily varied.

The piston carries a crosshead at its upper end with two sheaves over which the body-lifting cable passes. A third sheave is placed at right angles to these two on the cylinder head and acts as a compensating device for distributing the stresses equally throughout the cable. It incidentally acts for simplicity, in limiting the cable to only two ends. Where a compensating lever is used instead of a sheave, two cables are necessary.

The ends of the cable are connected by yokes to substantial brackets on the front of the body, as shown in Fig. 1. In operation, oil is drawn from the cylinder head, through the three-way valve, through the pump and then under pressure to the bottom of the piston. If it is desired to hold the body in any position, the valve is turned round shutting off the intake pipe. To lower the body the valve is turned round so that the oil is bypassed around the pump from the lower part of the cylinder to the upper. The weight of the body is sufficient to lower the piston.

The oil used is preferably a good grade of ice-machine oil in the winter and a somewhat heavier oil in summer. In fact, the best oil to use depends to some extent upon climatic conditions.

The oil pressure required to lift a full five-ton load plus the body is more than 400 lb. per sq.in. The body can be lifted in 8 sec.



Arrangement of Pierce Dump Hoist on Truck Frame

Probably the most severe test to which a truck equipped with this device has been subjected was in dumping a five-ton load every 10 min. 10 hr. per day for the past year and a half. This particular truck, owned by the McKelvey-Hine Contracting Co., Youngstown, Ohio, has made about 30,000 dumps with very little attention to the hoisting equipment.

Cutting Out a Large Concrete Turbine Foundation

The removal of large portions of a mass-concrete foundation about 40x40 ft. in plan by 12 ft. deep, in the Gold St. Generating Station of the Edison Electric Illuminating Co., of Brooklyn, without interfering with the operation of the plant, is being accomplished at the present time, to make way for a new concrete-and-steel

*By John Younger, Chief Engineer, Truck Department Pierce-Arrow Motor Car Co., Buffalo, N. Y.

grillage and steel superstructure for a large horizontal turbo-generator. The concrete foundation was built in 1911 when it was proposed to install a 12,000-kw. vertical unit. It was decided, however, to install a larger unit,

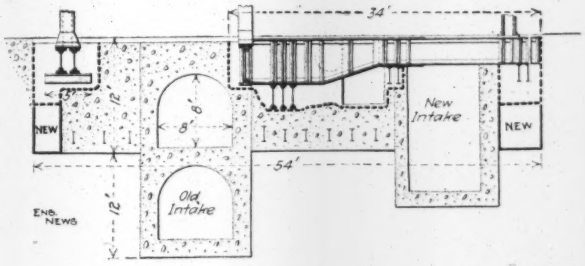


FIG. 1. RECONSTRUCTED TURBINE FOUNDATION

and because such units are available in the horizontal type at less cost per kilowatt, on account of greater speed, a 22,000-kw. horizontal unit was selected.

The amount of cutting required is indicated on the drawing, which also shows the grillages set for the proposed steel structure. The method employed was to drill a series of 2-in. holes about 6 in. c. to c., 6 in. back of the face, and break down by plug and feathers the material between holes and face. The cutting started along the line of the 30-in. atmospheric exhaust (Fig. 2), situated about 10 in. below the surface, and proceeded in 3- to 4-ft. stages to a maximum depth of 12 ft.

The first step in the whole work was to build a substantial wood screen from the top of the foundation (basement floor level) to an elevation 6 ft. above the turbine-room floor, through the opening left in the latter floor, for the future unit. This screen or partition served to isolate the concrete-cutting from the various station operations. It was commenced on Aug. 6, by a force of 4 carpenters and 2 laborers.

FIG. 3. OPENING FOR CORNER GRILLAGES

(For grillages shown at right of Fig. 1. Two drills in place. Gravel concrete at left, broken-stone concrete at right.)

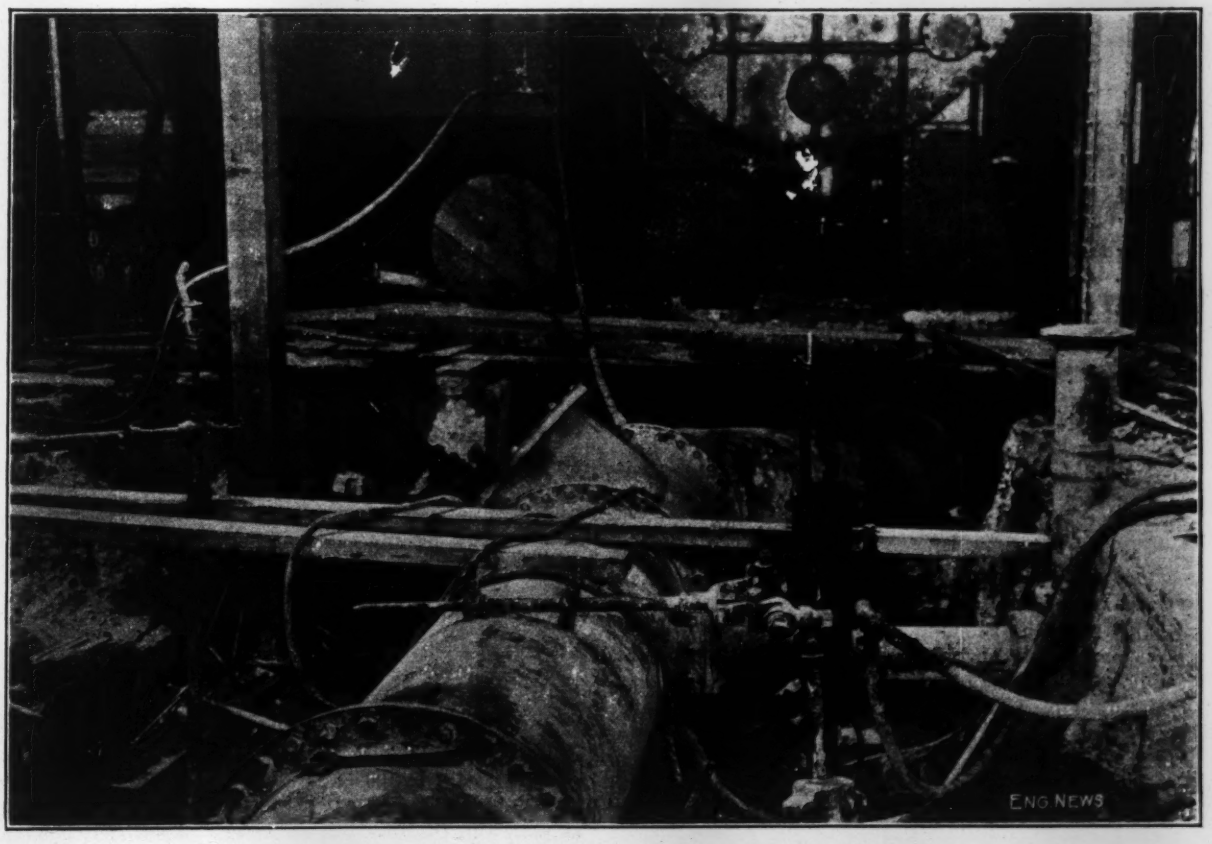


FIG. 2. MAIN CUT, SHOWING ATMOSPHERIC EXHAUST EXPOSED

(Condenser of adjacent turbine, at top of view. Wood forms at left separated concrete wall of old condensing water tunnels from the concrete turbine foundation. Face at right is gravel concrete.)

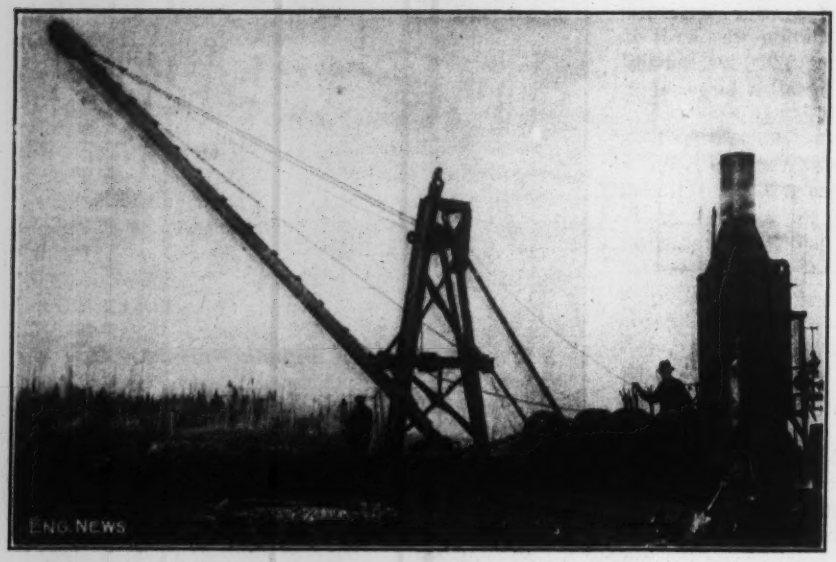


FIG. 1. LAND-CLEARING MACHINE

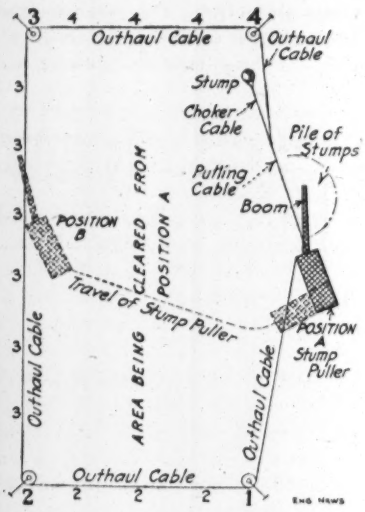


FIG. 2. WORKING ARRANGEMENT IN CLEARING LAND BY MACHINE

To obtain sufficient width it was necessary to cut a slice from an abandoned engine foundation built in 1897. This concrete was a mix of cement, sand and broken stone, while gravel was used in the 1913 structure in place of the stone. The work developed that the older material broke away in chunks under the action of the plug and feathers; but the gravel concrete crumbled, running up the cost of its removal (see Fig. 3, in this connection).

The cutting is carried on by two shifts. The first works from 7 a.m. to 6 p.m. and comprises about 45 men; the night force works from 6 p.m. to 5 a.m. and averages 20 men. A total of 6 drills (both steam and air) were used. The work is scheduled for completion by Oct. 1.

The work is being done by Barth S. Cronin & Co., under the supervision of G. L. Knight, Designing Engineer of the Edison Co.; H. B. Morrison, Chief Inspector.

Stump-Pulling Machine for Clearing Land

In the clearing of timbered land, extensive use is made of machines for hauling, skidding and loading the logs and trees; but there is less general use of machines for the usually slow and heavy work of removing the stumps. The machine here described is intended for the entire work of clearing; it first hauls in and stacks or loads the trees and logs; then it pulls up the stumps, hauls them in, and stacks them ready to be burned. A portable machine, moving from stump to stump and pulling them vertically, was described in ENGINEERING NEWS, Aug. 27, 1914, but the machine described below will clear a tract of five acres (about 600x350 ft.) at one setting, and it pulls the stumps with a horizontal cable.

The machine, shown in Fig. 1, consists of a frame of 15-in. steel I-beams mounted on a pair of longitudinal 9-in. I-beams which form the runners. Each runner is curved upward to enable the machine to ride over obstructions, and is shod with a steel plate 20 in. wide. Steel plates are riveted to the bottom of the floor-beams of the frame, to protect the machinery from dirt and to give additional support on very soft ground. At the front end is a steel A-frame, 16 ft. high, to which are attached the guy lines of the 36-ft. boom. At the rear end is the hoisting engine and a vertical boiler, and over it may be a canopy roof for the protection of the operator. The frame is 32x9 ft., and the machine (with its cables and all equipment complete) weighs about 35 tons. Lighter machines of the same type are built.

A double-cylinder three-drum engine is used, with cylinders 10x12 in. for the larger machines. The front drum carries the pulling cable, and is geared for two speeds; for pulling the stump it exerts a pull of 145,000 lb. with a speed of 30 ft. per min., while for skidding or hauling in the stump it has a speed of 350 ft. per min. The rear drum carries the outhaul cable for running out the pulling cable after it has brought in a stump, giving a speed of 800 ft. per min. The middle drum carries the piling line which is led over the boom and is used for stacking the stumps in piles ready for burning. The hoisting capacity is 10 tons.

When the machine is in position it is anchored by steel spuds driven into the ground through holes in the runners, or by chains attached to trees or stumps in the rear. The outhaul cable is then led around the area to be cleared, being passed through snatch blocks, as shown at 1, 2, 3 and 4, in Fig. 2, and led back to the machine, where its end is attached to the pulling cable.

The drum then hauls on the outhaul cable, thus running out the pulling cable to the first stump (Fig. 2). A choker line or short steel cable, having a hook at one end and a loop in the other, is then wrapped around the stump, and the loop is slipped over the hook on the pulling cable. The drum of this cable then hauls in on the slow gear until the stump is pulled from the ground, and then on the high gear until the stump is deposited at the machine. The choker line is released automatically and taken back by the outhaul cable.

When the machine has pulled all the stumps between it and point 4, the snatch block is shifted successively to points in the line 4-3, as shown. Then snatch block No. 4 is dispensed with, and the cable led directly to block No. 3. This in turn is shifted toward No. 2, and is

then removed, and No. 2 is then shifted in the same way. As the positions of the snatch block are changed, the machine swings so that it is always in the line of the direct pull.

The entire area having been cleared, the pulling line is run out and anchored at the next position (shown at *B*, Fig. 2) and by hauling on this cable the machine pulls itself forward to that position. The outhaul cable is then led around the new area and work proceeds as before.

One piece of clearing done in Texas was on heavy clay land with pine stumps 10 to 40 in. diameter averaging 44 per acre. The machine pulled, skidded and piled about 110 stumps per day, at a cost of about 28c. per stump, or $12.32 per acre, clearing about 2½ acres per day. The working force was as follows, with a total daily cost of $30:

1 Foreman	$5.00	2 Hookers (each)	$2.00
1 Engineman	3.50	1 Tongman	2.00
1 Leverman	2.00	1 Stump grubber	1.50
1 Fireman	2.00	1 Water team	4.00
1 Helper	2.00	1 Fuel team	4.00

The machine is built by the Clyde Iron Works, of Duluth, Minn.

General Points on Moving Large Structures*

In preparing a building or structure of any kind for raising and moving it will be necessary to make a careful study of the structure. The weight should be carefully estimated, the general construction of the building should be understood, in order to know the distribution of loads on present foundations. The character of ground over which the structure is to be moved should be considered, especially if the building is of a heavy type.

After the above points have been carefully considered, a layout is made showing the manner of picking up the structure, which is done in the case of a brick or stone structure by inserting either beams or heavy cross timbers at proper places to take the load without causing strains in the main structure, when the building is raised. The main principle in raising structures is to keep conditions as nearly as they were, when on original foundations.

*From a paper by Geo. W. Nichols, Engineer, John Eichlacy, Jr., Co., Pittsburgh, Penn., "Principles and Details Involved in the Moving of Large Structures," "Proceedings" of the Engineers' Society of Western Pennsylvania, April, 1914.

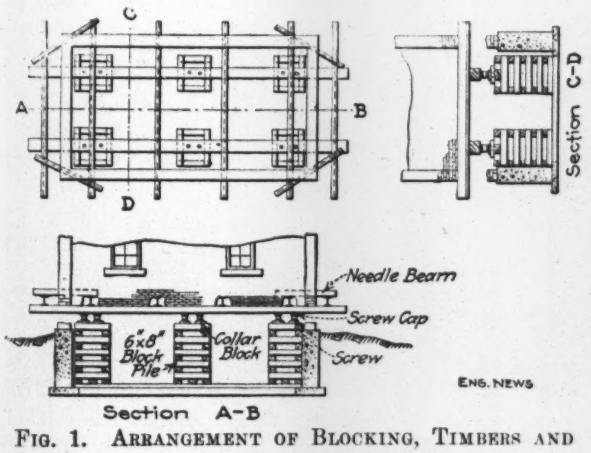


FIG. 1. ARRANGEMENT OF BLOCKING, TIMBERS AND SCREWS FOR RAISING A BUILDING

In the case of steel structures, special consideration is given to each individual case and no set method can be laid down for the work, however, the general principles are applicable to all structures.

The following sketch, Fig. 1, shows the manner of building a blocking and the setting of timbers and arrangement of screws for raising a structure. Regularity and care must be used in building the blocking and in the manner of setting the screws and locating cross-timbers for taking up the building.

After the building has been raised the required height and it is desired to move it, oak runs are built and the building lowered on rollers which bear on 6x8-in. oak runs below and on roller planks above, after which the jackscrews are removed. This is shown by the sketch, Fig. 2.

In case it is desired to turn the building slightly, the rollers can be "cut," that is, set at a slight angle to the general direction and gradually brought over to proper line. Cutting the rollers is a term used for knocking one end of the roller slightly with a hammer to change the general direction of the structure being moved. However, it is sometimes necessary to actually cut the rollers with a saw. Where the building is to be given a quarter or half turn, or a complete turn, a pivot point is selected and runs laid and rollers set to operate about this point (Fig. 3).

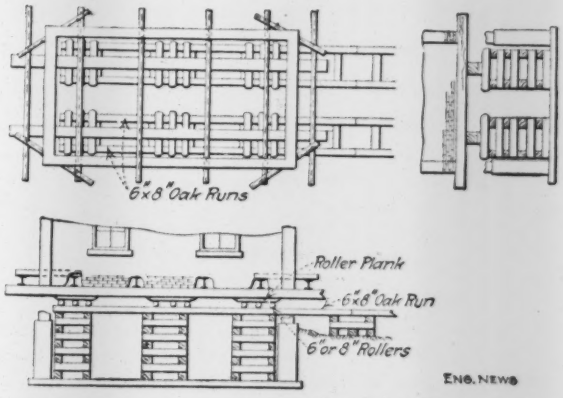


FIG. 2. ARRANGEMENT OF RUNS AND ROLLERS FOR MOVING A BUILDING

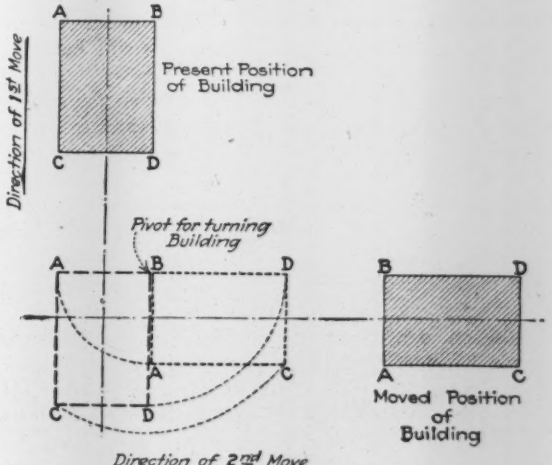


FIG. 3. PLAN FOR MOVING A BUILDING AND MAKING A QUARTER TURN

In the alteration of buildings such as the change in fronts or shoring of floors or the supporting of heavy structures where high blocking would be required, pump logs or drums are used. Pump logs are timbers, usually 8x8 in. in size, but often larger, one end of which is bored to a 4½-in. diameter about 18 in. deep. In this hole operates the screw, the lower part of nut sets in the 4½-in. hole in the timber and the flange of nut bears directly on the bottom of timber—more often a collar block is used to form a bearing for the nut. Drums are usually set in position with the screw at the lower end, so that the screw may be more easily operated.

In the moving of brick structures great care is required to keep the building level and the movement uniform. It is usually customary to run cables entirely around the building and tighten by means of ratchets. In attaching the ropes to take the blocks for moving a brick structure, these are not connected directly to any part of the brick building, but to the timber or steel grillage upon which the building sets.

The building is watched carefully by all the men to assure raising in a level position. These levels are procured by means of ordinary carpenters' spirit levels, which are placed on runs and timbers which support the structures and these kept as near level as possible. In raising the building a number of screws are divided among the men. Each man may have ten screws to turn. Each man takes his screws and makes two rounds on a given signal. He starts at one end and makes a quarter turn and goes through to the end of his screws, and then returns and stops until every one else is through and until the signal to turn is given again.

An Erection Economy: Marking Structural Members for their Connections

By E. J. Knapp*

A study of field requirements and conditions can save much time and labor. Shops are too apt to confine their economy practices within their walls, forgetting that it does not matter whether the money is spent in the drawing room, the shop, or the field, it is all out of the same pocket. Possibly the work will cost more per hour in one place than it will in another, but if it accomplishes two or three hours' worth of saving elsewhere, we will have results on the profit side.

Two suggestions are made in the following for saving in the field, at the expense of a little more work in drafting-room and shop. While no actual trial of them has been made, their advantages are so obvious as to make it certain that they would save more than they cost.

The writer proposes (1) that every shipping member of a structure be marked with the symbols of the connecting members, at the points where they connect, and (2) that each end of each member be marked with its final position, e.g., the top side "Top," the end toward the river "Water End," and so on. Then the erector will simply have to look at the end of the member for the connection symbol, find the matching piece, see from the marking on that piece which way it goes, hook his rigging to it, and send it up.

*455 East 118th St., Cleveland, Ohio.

Note erection diagram, Fig. 1, and suppose *EG2* is already in position. The detailing of *EG2* and its connecting members *TL9* and *TL10* is shown in Fig. 2. If, when this girder is assembled in the shop, the marks of the connecting pieces are painted on the gusset plates, the erector will know without the detail drawings how to place these members in the structure, which he otherwise would not know.

The system would work out the same as match-marking. The erector would note the symbol on a connection and call it down to the men on the ground; the latter, in hooking onto it to send it up, would be governed by the marking found on the piece as to which end goes which way. The foreman would not have to get the detail drawing and check up a piece to see which is the top or water end, his men waiting for instructions in the meantime. It is hard to work with drawings out in the open, where the wind and possibly rain can get at them; in cold weather it becomes doubly hard.

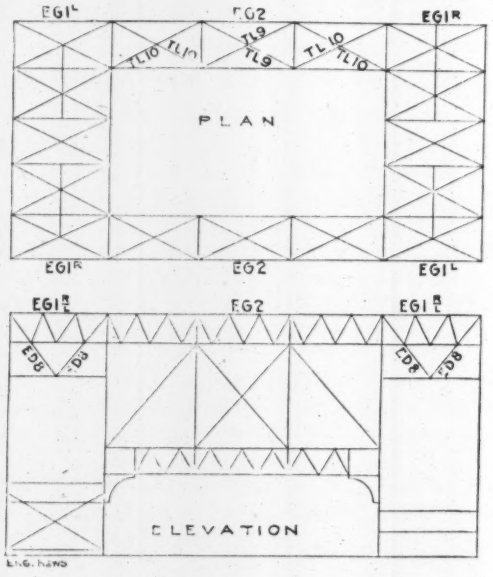


Fig. 1. Usual Marking of Members in Erection Diagrams

Some companies go so far as to put a man at picking out iron. It is this man's duty to always keep ahead of the erecting gang by having each piece at hand when it is wanted. He designates by marking or word of mouth, the way a piece goes into the structure. This method is not practical when there are more than one or two raising gangs, as that is about all the man supply and still have time to study out the details to get his information.

I have known erection jobs where there have been five and sometimes six raising gangs. Fig. 3 gives a good example of such a case: five bridges, two at one site and three at another, 500 ft. away, all handled by one erection superintendent. As time was a big factor, two sets of falsework were used, and on each bridge a raising gang worked at either end, making four gangs to begin with. As soon as one bridge span was complete, the bridge was run off the falsework and another one started, and another gang set to work putting in track stringers and details. Thus, finally six gangs were raising iron;

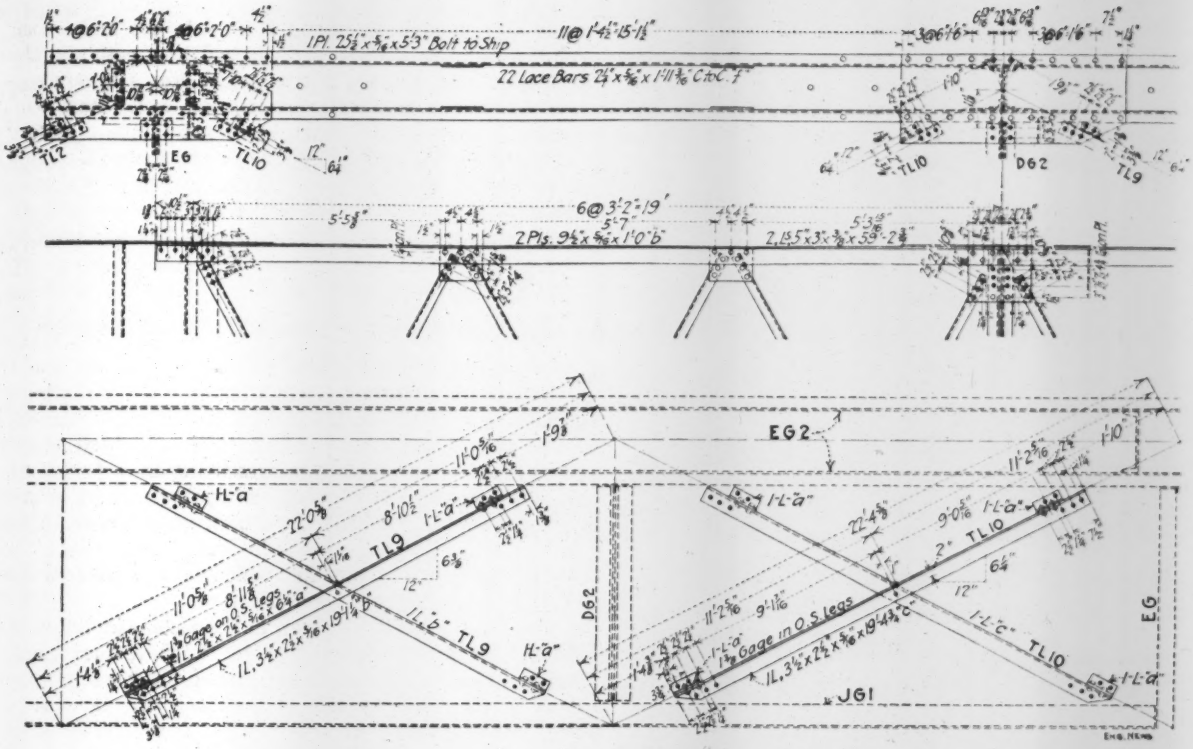


FIG. 2. DETAILS OF THREE MEMBERS OF FIG. 1

and in addition there were machinists and electricians. Since in most cases a blueprint is Greek to the pusher or foreman of the gang, it is necessary that he have someone at work to pick the iron out and mark it as to its location in each bridge. In this case two men were kept busy on such work, and even then mistakes were made, sometimes a piece being put up wrong and taken down again, because they did not have sufficient time to study out the details.

There is no doubt that a great deal of time can be saved and mistakes forestalled by designating in the shop the position a member occupies in the finished structure. To enable the shop to do this properly, the marking should be noted on the detail drawing. The draftsman would need but very little more time to put this information on the drawing, so that the shop can use it on sight.

An argument against adding more information to a detail drawing is that it clutters up the drawing. But the more information is placed on a drawing, the less the

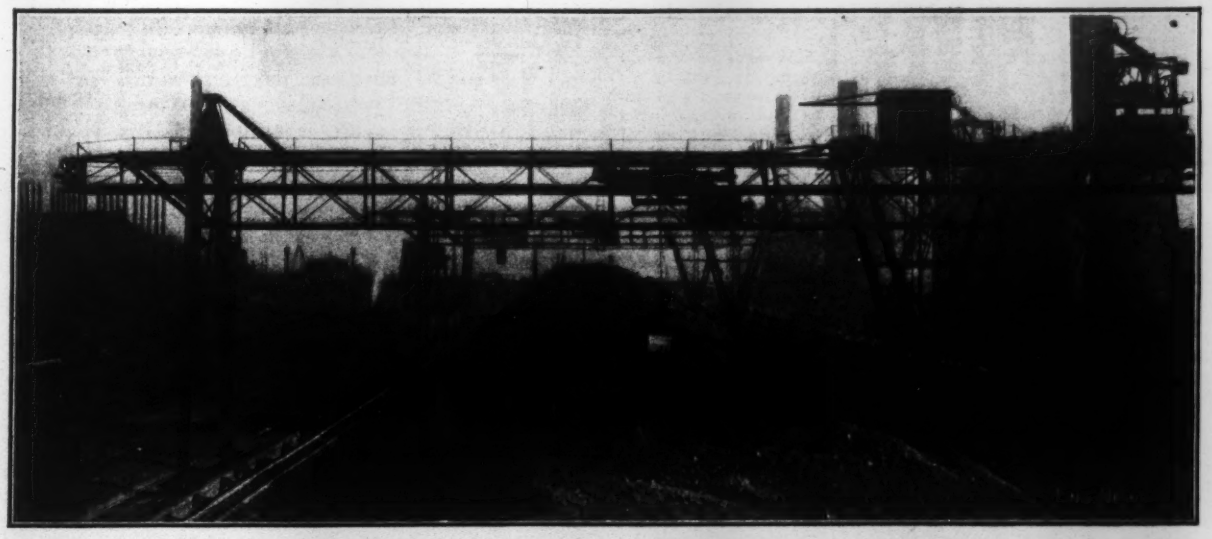


FIG. 3. A GROUP OF ORE BRIDGES ERECTED BY ONE FIELD ORGANIZATION

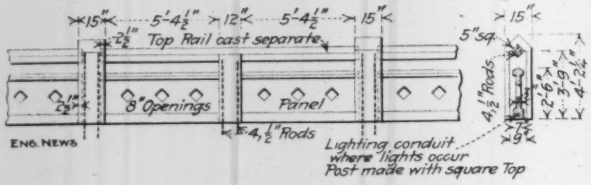
Part of ore-handling plant at Edgar Thompson Steel Works, Bessemer, Penn. Built by Brown Hoisting Machinery Co. Two of the five bridges are at right angles to the three shown, and cannot be seen in the picture.

shop men and erectors will have to be mind readers.

As far as increasing the shop expense, this method would only add to one man's duties, the shop inspector or checker. When he is going over a member for its final inspection, he can perform the necessary marking as noted on the drawing.

A Special Reinforced-Concrete Bridge Railing

A partially precast concrete handrailing was placed on the Pleasant St. Viaduct of the Delaware, Lackawanna & Western R.R., at Utica, N. Y., by Peters & Kiehm, contractors for the bridge. The accompanying drawing shows the detail of the construction. The railing was divided so that a large 15-in. square post was placed every 13 it. Midway between these posts was set a smaller 12-in. post, which extended in height only to the center of the top rail and acted as a support to that rail. Between



Railing for Pleasant St. Viaduct, D. L. & W. R.R. Utica, N. Y.

these posts were 3-in. vertical slabs serving as panels and provided with 8-in. square diamond-shape openings as ornaments.

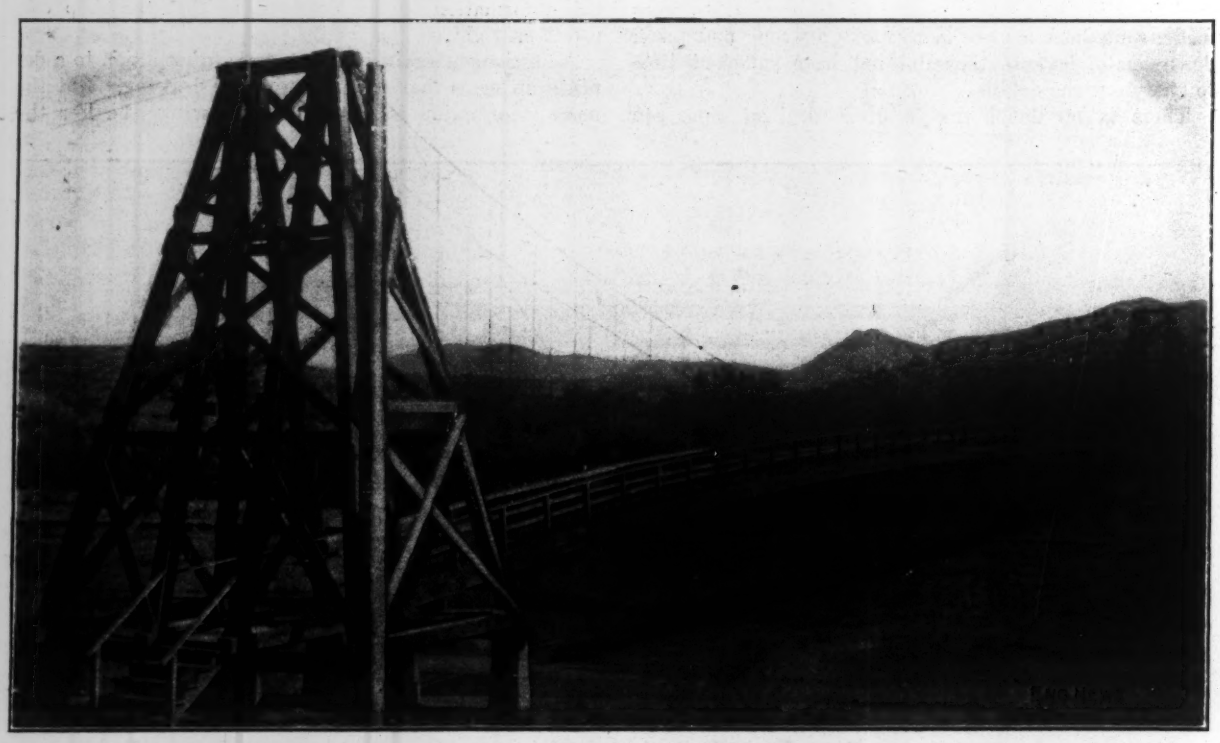
In building the rail the small intermediate post and the two adjacent panels were first cast in place and were made long enough to extend 2 in. into the main post. After a number of these sections had been cast and the forms removed, the top railing, which was a square section set with a diagonal vertical, and which had been previously cast on the ground was put in place resting in the groove left in the top of the short mid-post. Then forms for the main post were placed and filled, the ends of the panel and of the top rail having been covered with grease and wrapped with paper to provide a slip joint at each of these main posts.

A Rough Wood Suspension Footbridge*

A suspension footbridge 273 ft. long was recently built across the Gila River near Kelvin, Ariz., by the Kelvin-Sultana Copper Co., to connect their mine and power plant and to accommodate miners living in Kelvin. Although designed only for pedestrians, single pieces of machinery weighing 1800 lb. have been taken across. The maximum load placed upon it to date was 3000 lb. The bridge carries a 4-in. pipe line which conveys boiler water from the mine to the power plant.

The general design is shown in the accompanying view. At the center the roadway is 15 ft. above mean high water. The wooden towers are carried on concrete foundations. On the west side of the river (the far side in the view) the former river bottom, now about 8 ft. above mean high water, forms a flat several hundred feet wide which affords poor bearing. The concrete foundations on this side are 14 ft. deep x 6 ft. wide at the base. On the opposite side the piers are about 3 ft. high. The towers, constructed of 10x10-in. Oregon pine posts with 3x8-

*Data furnished by Arthur L. Flagg, Kelvin, Ariz., who built the bridge.



General View of 273-Ft. Suspension Bridge

in. bracing, are 21 ft. square at the base and 31 ft. 5 in. high.

The two cables are made each of two ¾-in. plowsteel ropes, which had seen about six months' service in hoisting. The floor, 4 ft. wide in the clear, is attached by ⅝-in. Ernst patent hangers passing through 4x6-in. cross-bars, on which rest two 4x8-in. and one 3x8-in. stringer. The floor of 2x12 is nailed directly to the stringers. Directly over each side stringer is a 4x6-in. guard timber, bolted through plank and stringer to the cross-bars.

The anchorages are concrete blocks. The cable ends are passed around several 16-ft. lengths of 90-lb. rail embedded in the concrete. On the power-plant side, turnbuckles are provided.

From the center of the bridge there are four guys to the bank, making an angle of 30° with the center line of the bridge. There is very slight sway to the bridge under ordinary loads.

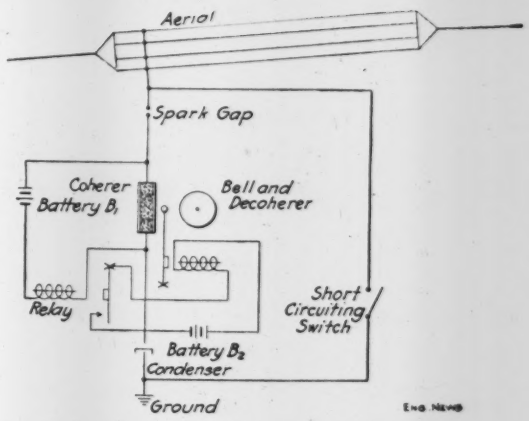
In building the bridge, as soon as the towers were completed the cables were hung and roughly adjusted to nearly the proper deflection. The hangers were then put on, beginning with the longest and working from both ends toward the center simultaneously. When the hangers were all placed, the deflection was adjusted (27.2 ft.), the floor laid, and the handrail put on.

A Detector of Approaching Storms

The storm detector recently developed by the engineers of the New York Edison Co. gives them warning of storms 2 to 7 hours before the actual clouds and darkness arrive and they are enabled to prepare for heavy drafts of lighting currents. The apparatus is very simple and should be of broad application wherever there is work under way which it is advisable to protect in advance from storms and darkness. A few detector stations scattered over the area served by a large electric-transmission network should give advance warning of impending local loads and line disturbances—helping the new art of load dispatching.

Practically all summer storms are accompanied by electrical disturbances, and these are detected by what is virtually a wireless-telegraph receiving circuit. Winter storms have but weak electrical manifestations, and are not yet as well detected.

As shown in the accompanying figure there is an aërial frame, a spark gap, a coherer, a condenser, a ground connection, a combined bell and decoherer, a relay, two batteries and a short-circuiting switch. The spark gap is to shut out radiations from radio-telegraph stations; the spherical terminals are about $^1/_{64}$ in. apart and storm surges will jump this distance. The coherer is like the earlier ones of wireless telegraphy—a short glass tube of small bore filled with nickel-silver filings between german-silver plugs. The bell is one of single-stroke connection mounted so that the clapper will back-strike the coherer tube. On passage of a storm impulse the coherer loses its high resistance so that steady current flows through it from its battery and causes the bell to tap. The return of the clapper jars the filings and restores the high resistance ready to report another storm impulse. The condenser was inserted in the Edison Company apparatus to prevent direct current from flowing; in many cases it could be omitted. The short-circuiting arrangement is needed to prevent damage to the set when the storm begins to break.



CONNECTION DIAGRAM OF STORM DETECTOR

At the New York station, it has been found that the bell begins to tap every 15 to 5 minutes when a storm is a few hours away. If it approaches nearer, then about two hours before it breaks the bell taps every minute or half minute. The bell rings continually an hour or a half-hour before the crux and then the set is short-circuited since no other warning is possible or needed.

Arrangements for Soil-Loading Tests

That the rather uncommon operation of testing the bearing capacity of foundation soil involves a number of troubles and complications was commented upon editorially in our issue of September 3, 1914. The following two descriptions of test arrangements which have proved satisfactory in actual use, received in response to our comments, may be instructive.

UNBRACED LOAD BALANCED ON SINGLE POST

Wm. P. Snow, Lewiston, Me., several years ago made soil tests with load balanced on a single post, as follows:

A large chimney was to be built close to a river bank and the bearing capacity of the subsoil had to be determined before designing the foundation. A test-pit was excavated to the proposed foundation depth, and showed a good coarse gravel, which was capable of carrying a heavy loading. While this gravel did not seem to call for the proposed test nevertheless the test was carried out for the information of outside parties.

A 12x12-in. iron plate was set level on the bottom of the pit and on it was placed a 10x12-in. post with top about 2 ft. above ground. When this post was carefully plumbed the hole was backfilled around it. A 12x16-in. timber 20 ft. long was laid over the top of the post as a loading beam. Under each end of it a timber crib was built to within a few inches of the beam, as a stop in case it got out of balance. Bricks were piled on the loading beam until the required intensity of loading was reached. There was no trouble in keeping the load balanced, the bricks being added with reasonable uniformity on either side of the post.

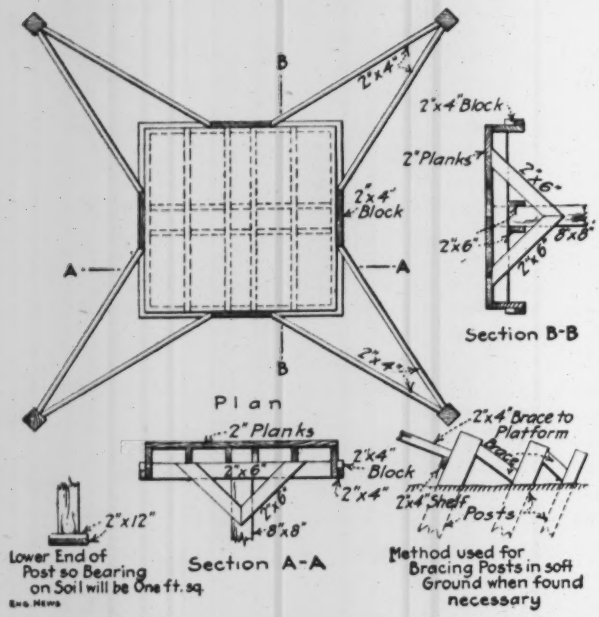
There was a slight compression under the first thousand pounds of load, but thereafter little or no settlement was perceptible up to the maximum applied loading of four or five tons per sq.ft. This test was carried out for Lockwood Greene & Co.

A similar test was made some time later on top of the ground, without backfill around the loading post, and there was no trouble in maintaining balance of the load on the post.

BRACED PLATFORM ON SINGLE POST

The loading platform arrangement described and shown in the following has been used by E. McCullough, Chicago, in a number of soil tests for building foundations.

The platform, of at least 10 tons capacity, is 6x6 ft., made of 2-in. planks resting on an outer frame of 2x12-in. plank and stiffened by four 2x6 joists below. Two additional 2x6's underneath these joists support the platform and are spiked to the middle post. The post is 8x8 or larger. The platform is braced to it by inclined 2x6 knees. The bearing area at the bottom of the post should be 1 sq.ft. This is



BRACED LOADING PLATFORM USED BY E. MCCULLOUGH

obtained by spiking to the foot of the post two thicknesses of 2-in. plank with the fibers crossed. There is no necessity of using a 12x12 post; it is much simpler to make a shoe as thus described than to build up the post of plank to get the proper bearing area at the bottom.

To receive the ends of props on the four sides of the platform a 2x4 strip is nailed around the outside of the frame along the lower edge of the 2x12 frame support, and at the middle of each side a piece of 2x4 about 2 ft. long is spiked on top of this strip, forming a lug against which props can be butted.

About five or six feet away from each corner of the platform a large post is driven, and if necessary it is braced. On the front of each post is nailed a block of wood at the height of the platform, and props resting on this block of wood extend to the blocks of 2x4 on the adjoining sides of the loading platform. Sticks of 2x4 are satisfactory as props. Their ends should rest rather loosely against post and platform, without binding. This will avoid their affecting the loading or settlement of the platform.

At the site of the test a hole is dug to the depth of the proposed foundation and the post is set in it. The post should be of such length as to bring the platform a little above ground level. A long spike driven in the center of the platform, long enough to go into the top of the post, is a good support for a leveling rod to take readings of settlement.

The load is placed as evenly as possible on the platform. The props should not bind and the load may be shifted and adjusted as it is placed so that the platform can go down without the props binding.

Elevations should be read after loading, and six hours later. The readings should be plotted and if the curve is a decided parabola the test load may be left until no settlement occurs. If after 18 hr. the curve shows no sign of being a decided parabola, the test load should be lightened. One-fourth of the test load which the post can carry for 24 hr. without settlement should be a safe load per square foot. The settlement during the loading of the platform may be several inches due to unavoidable rocking of the test arrangement, but this should be ignored and only the settlement occurring after the full load is applied should be considered.

Concussion Effects in Pavements; Information on Tests Wanted

There is a good deal of difference of opinion as to whether 6 in. of cement-concrete foundation is sufficient for heavy-traffic street pavements. One of the arguments for heavier foundations is that thin foundation slabs may be fractured by vibrations produced by heavy vehicles passing at high speed. But no experimental study has been made of this phase of the pavement problem, so far as we are able to find.

Several important practical questions come up in this connection. Two fundamental questions are:

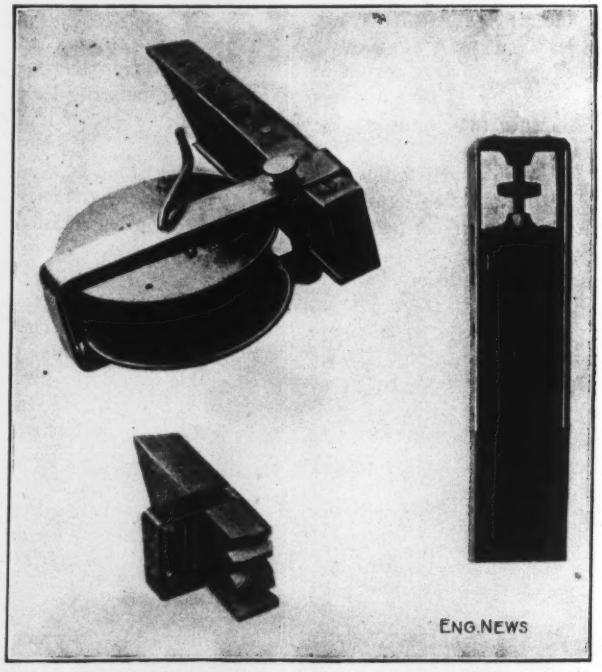
1. *Is one kind of pavement surfacing as hard on the foundation as another?*

2. *Does asphalt or wood-block surface have a cushioning effect, as compared with brick or stone block? Which results in longer life of the foundation?*

Answers to these questions are solicited. Further, if any tests or measurements have been made of vibration (concussion) effects in pavements, we would be glad to hear of it.

NOTES

Selfcomputing Leveling Rod—A new leveling rod has the number face on an endless steel tape instead of on the fixed material of the rod, and, the tape being carried on two end rollers, the graduations can be set to match the elevation of the benchmark. Thus the level-reading on any stake gives its elevation direct, without any addition, subtraction or other of the usual level-record computations. In construction the rod is simple; the tape roller at either end is the chief addition to the ordinary rod. The tape is joined by a hook joint in the rear half, and it can be taken off and replaced with

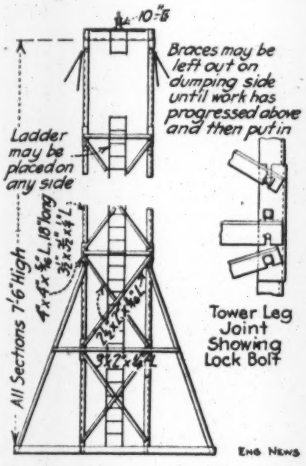


TAPE REEL, TAPE ROLLER AND CLAMP; SELFCOMPUTING LEVELING ROD

very little trouble. A winding reel may be attached near the bottom end of the rod, for use in putting the ribbon on the rod and taking it off. Of course, the graduations on the tape increase from top to bottom, as on an inverted rod, though the figures themselves are right side up.

The rod itself is made in three sections with telescope joints, so that for transportation it can be brought down to a length of 4½ ft. An oval target sliding on the rod in the usual way enables the rod to be used as target rod, although with suitable graduations it is probably best adapted for self-reading work. The face of the rod is made wider than that of the usual target rod, and this helps in reading from the instrument. The rod can be made with any desired graduations. The Chicago Steel Tape Co., 6231 Cottage Grove Ave., Chicago, makes and sells the new rod. The present list price is in the neighborhood of $17.

Steel Concreting Tower Designed for Rapid Erection—Slots in place of bolt-holes are the essential feature of a steel concreting tower which the Yorke Derrick Co., Washington, Penn., has just begun to manufacture. The parts of the tower are put together or dismantled without removing nuts or bolts, but slip apart as soon as the nuts are slacked off. This applies to the splices of the tower legs as well as to the attachment of the horizontal struts and diagonals. The leg splices are made by means of a piece of angle 18 in. long riveted to the end of one of the leg sections and projecting to engage the other; its end is slotted, and two bolts in the engaged leg section enter the slot, while similarly two slots in that section receive two bolts in the splice angle. Thus the two leg sections go together by a simple telescope joint, which is held firm by tightening the four bolts.


10"⊏
Braces may be left out on dumping side until work has progressed above and then put in
Ladder may be placed on any side
All Sections 7'6" High
Tower Leg Joint Showing Lock Bolt
ENG NEWS

STEEL CONCRETING TOWER WITH SLOTTED BOLT-HOLES

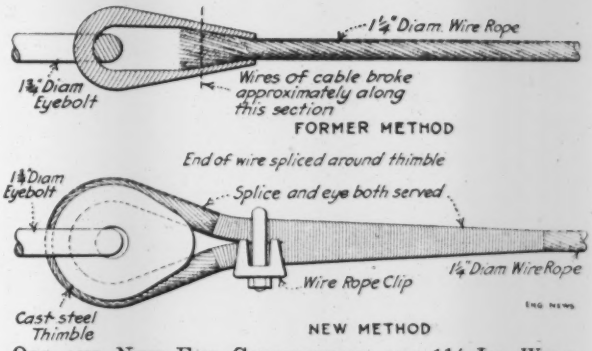
This principle of construction has been used by the same company for a long time in building oil derricks, but only recently has been applied to a concreting tower. The new tower is being made in sizes of 4 ft. to 5 ft. clear width of hoistway, and in any height. The sections are 7½ ft. high, except that guides and ladder are put on in 15-ft. lengths. The adjoining sketch shows the construction clearly. At the top of the tower a 10-in. channel on each of two opposite faces of the tower, taking the place of the regular strut, furnishes a support for the sheave beams. The top frame can be connected at the end of any tower section in place of the horizontal struts and the succeeding tower section.

A single tower section weighs about 500 lb. and the base section (base spread to 15-ft. length) weighs 800 lb.

Cable Socket Break and New Type of Cable Connection—The breaking of a 1¼-in. wire rope cable socket on the U. S. seagoing suction dredge "New Orleans" a year ago, as described by Maj. E. H. Schulz in "Professional Memoirs," Sept.-Oct., 1914, led to the design of a new cable attachment which is now used. Two 1¼-in. ropes hold up the dredge arm. On Sept. 23, 1913, while at work on the outer bar of Southwest Pass, both these ropes broke at the sockets, dropping the dredge arm. In attempting to lift the arm there was a series of breaks of cables and of hoisting tackle as a result of which it was ten days before the arm was finally raised and secured again.

Two similar socket connections were tested at Tulane University. They broke at loads of 53,000 and 58,000 lb., although the initial stages of fracture occurred at 44,000 and 38,000 lb. respectively. The cable itself is advertised to have a breaking strength of 100,000 lb., but a piece tested with leaded end connections broke at 89,000 lb., the first stages of fracture occurring at 63,000 lb.

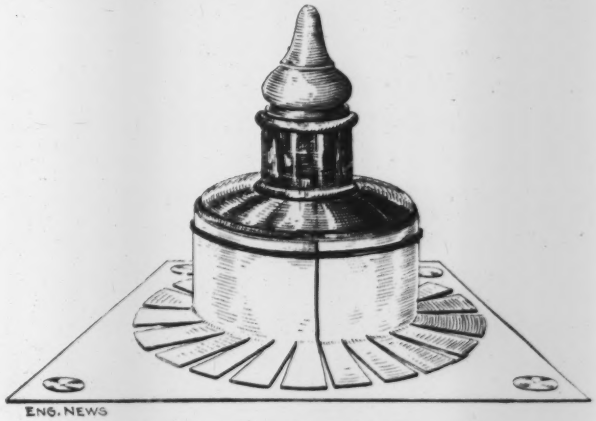
As a result of the accident to the dredge and the tests, the socket connection was concluded to be undesirable and a spliced-in eye connection was employed. (See sketch). The cable is spliced around a thimble, the splice served with wire, and the end of the loop close to the thimble held by a Crosby clip. The old method of connection is described as follows: The ends of the wire were passed through the socket; served inside the socket with wire; end unlaced; heart taken out; ends of wire bent over into the socket; and spike driven into the heart. The ends were then seized together and pulled into the socket with the tackle. After the end was pulled in, the socket was poured full of Magnolia white metal and allowed to cool. The new eye connection has not been tested so far as reported.



OLD AND NEW END CONNECTIONS FOR 1¼-IN. WIRE ROPES HOLDING DREDGE ARM, U. S. SUCTION DREDGE "NEW ORLEANS"

A Simple Ink-Bottle Holder—An even simpler ink-bottle holder than that described in this department on May 28, been called to mind by a correspondent.

First wrap a piece of drawing paper around the bottle and hold in place by means of rubber bands. Then cut the projecting portion into strips. Next, bend the strips over



ANOTHER INK-BOTTLE HOLDER

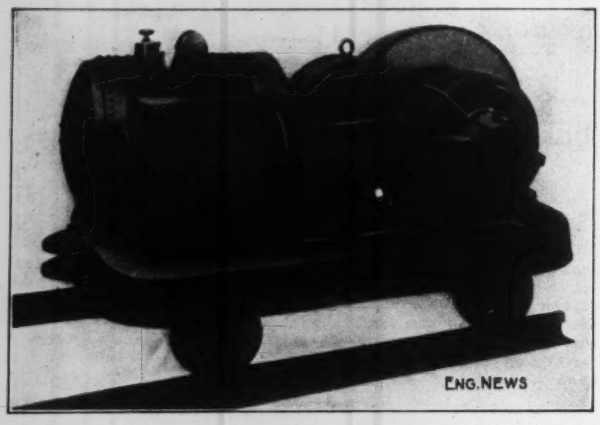
and paste on another piece of drawing paper, and fasten to the drawing board or drawing table with thumb tacks, as illustrated in the cut.

The disadvantage of immovability could be overcome by fastening to a block of wood ,instead of to the drafting table.

How to Turn a Revolving Shovel in a Small Space—The ordinary method of turning a revolving shovel around in a cut is generally a rather lengthy process of backing and filing. A much quicker and simpler method is given below, but we do not recommend this unless the operator is pretty sure of himself. Suppose it is desired to make a right angle turn to the right. Swing the shovel until the boom is over the steering axle wheel, the opposite way from the direction in which it is desired to move. Drop the dipper to the ground, then thrust down with the crowding engines and at the same time propel ahead. This will raise the front wheels off the ground. The hog rods will probably be slack at this time. Then swing. This will slue the rear wheels. By repeating this two or three times, a right angle turn may be effected. Another method which is often practiced when it does not seem advisable to slue because of the condition of the ground or other reasons, is to slip fishplates under the front wheels, with the flanges pointing in the direction in which it is de-

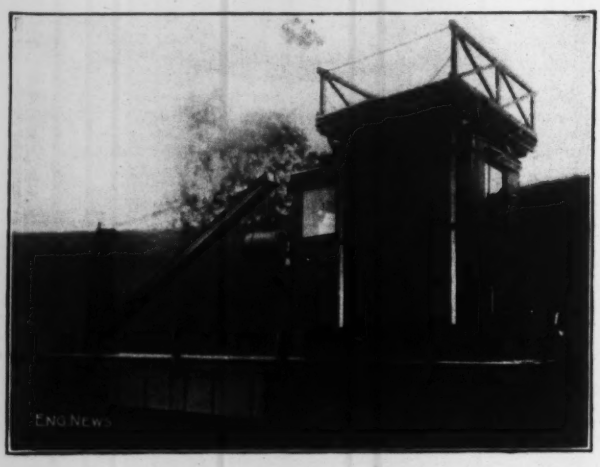
sired to turn the shovel. Propelling the shovel against these flanges will cause the wheels to slip on the plates and turn in the proper direction. [The "Excavating Engineer" for July, 1914.]

A Portable Electric Compressor Unit for mines and industrial plants where tracks are laid is shown in the accompanying figure, as developed by the Sullivan Machinery Co., of Chicago. A rugged design of compressor is mounted on a bedplate casting together with a 15-hp. motor, storage tank and starting rheostat. The bedplate forms the truck.



A Portable Electric Compressor Unit

Storage Battery Emergency and Construction Car—The accompanying figure shows one of four emergency, wrecking and construction cars built by the Field Omnibus Co., of New York, for the Havana Central R.R. The cars will operate from the overhead trolley on certain sections of the line and from storage batteries where there is no overhead construction. The battery (a 280-cell Edison nickel-iron) may be charged directly at trolley voltage. The speed on trolley current is 35 miles per hour, and 20 on the batteries; 70 miles run per charge was guaranteed and reported exceeded by 50%. A hoist motor and air compressor are operated by



Storage Battery Emergency and Construction Car

battery current. For propulsion, there are two 25-hp. motors, both on one truck. Journals have roller bearings. An average energy consumption of 30.2 watts per ton mile was shown during a 60-mile trial trip over tracks of the Pennsylvania R.R. The car is not intended as a locomotive, but on trial a 25-ton car was pushed up a 7% grade, running on the batteries after a 65-mile trip.

A Special Pipe Cutter and Die Stock is being made by the Ware Coupling & Nipple Co., Ware Mass., for repairing pipe lines broken off close to or inside walls. It works through holes of 6-in. diameter to a depth of 18 in. The device comprises a guide sleeve, a long stem, a die or cutter socket between the two, and a ratchet handle.

A Rivet Buster, to be used in place of a rivet set with a pneumatic riveting hammer, has recently been brought out by the Ingersoll-Rand Co., of New York City. This is a small chisel with the socket end shaped, as with the rivet set, to be held in place by a safety spring.

Highway Notes

Kinds of Road Construction in New York State—Since May, 1913, the New York State Highway Department has placed under contract a total of 1003.12 miles of highways. These contracts are made up of the following mileage under different types of construction:

Waterbound macadam	286.90
Waterbound macadam, hot oil	10.87
Waterbound macadam, cold oil	10.06
Bituminous macadam	352.31
Concrete	217.13
Concrete, bituminous top	8.34
Brick	90.53
Asphalt block	6.83
Stone block	1.93
Other types	18.22

Combination Concrete Storm Drain and Road—A method of taking care of the semi-annual runoff of large volumes of water by building a concrete trough 24 ft. wide and 12 in. deep, which serves as a drainage ditch in wet weather and as road in dry weather, has proved both economical and efficient, in a ranch section about 18 miles from Los Angeles, Calif. The pavement surface is a flat slab 24 ft. wide and 4 in. thick. The concrete curb is 12 in. high, 12 in. wide at the base and 5 in. wide at the top. At road intersections the curb flares out like the edge of a saucer. Transverse expansion joints are placed every 25 ft. The pavement surface is covered with Ott 95% wood oil spread ½ gal. per sq.yd., over which is sprinkled sand and crushed stone. The combined road and drain is 4500 ft. long and cost $1.08 per sq.yd. for the pavement and 30c. per lin.ft. for the curb. F. H. Joyner was engineer and the Davidson Construction Co., of Los Angeles, the contractor. [Information from the September issue of "Western Engineering."]

The Economy of Road Machinery—Many townships in Illinois have chosen to do all road grading and leveling with a heavy power machine and leveler. Such equipment has proven quite satisfactory for heavy grading work, but a little expensive for leveling work. Experience shows that the cost of running a tractor and leveler, including helpers, is from $12 to $15 per day, exclusive of the heavy depreciation and interest on the investment, which may vary from $400 to $700 annually. Assuming that the tractor outfit will cover 15 miles per day, and that it is used by the average township 40 days out of the year, it would cost between $2 and $3 per mile for maintenance work, which is about double the cost of maintenance work with the ordinary drag. However, if this same equipment could be used for six months in each year, the outfit would be much more efficient, and would probably not have as high an annual depreciation, as a more competent operator could be secured for this length of service. This, therefore, would indicate that such equipment should be owned by the counties, and loaned to the townships and districts at actual cost, rather than all individual townships buying such equipment. [B. H. Piepmeier, Assistant Engineer, Illinois State Highway Department in July issue of "Illinois Highways."]

Some New York State Experience with Tar-Covered Concrete Roads—Many miles of concrete road construction exist in the vicinity of Syracuse. These roads are of more than local interest and are being observed by road builders in different parts of the country. It is worth while here to explain that the covering placed on these roads is a thin veneer of tar and stone screenings, sand, or fine gravel. This cover has not as yet yielded perfect results. The idea in placing it is to obtain an economical wearing surface which can be easily repaired at a low expense, while the real body and foundation of the road remain practically permanent. Experience in the past two years has shown that it is difficult to get this cover to adhere perfectly to the concrete; it wears off in spots and in others seeming to take the wear perfectly. During the present summer several miles of this class of top have been repaired, and if the appearance of the work is any criterion, it seems that the patches will give good service. It also seems probable, on account of the low cost of patching, that the first cover can be applied with the expectancy that about one-half of it will come off the first season, requiring patching the following year and still be an economical proposition. The aim of our experiments, however, is to be able to apply this cover so that the first application will require only occasional repairs.—Chas. J. McDonough, Division Engineer, New York State Highway Department, in August issue of the "New York Highway News."

Editorials

The River and Harbor Bill

The searching criticism of the River and Harbor Bill by Senator Burton, of Ohio, referred to in our last issue, finally caused the Senate on Sept. 21, to refer the $53,000,000 bill back to the committee with instructions to report a new bill carrying appropriations of not more than $20,000,000, thus saving on this one appropriation bill alone substantially a third of the amount necessary to offset the deficit in the government's revenues due to the war abroad.

There need be no alarm that the interests of the country are to suffer and that necessary river and harbor work is to be suspended because of this sweeping cut in the River and Harbor Bill, for as Senator Burton showed, in his masterly review before the Senate, there is a large amount of money still available from previous years' appropriations with which river and harbor work can be prosecuted.

The unexpended appropriations for river and harbor work on June 30 last amounted to the sum of $45,338,000. In addition to that, the sundry civil appropriation bill, approved on Aug. 1, provided $7,000,000 additional. Thus there is over $52,000,000 of money available for river and harbor work this year without passing any appropriation bill at all. This is far more than the amount which has been expended in any year on river and harbor work. In 1912, the total expenditure on rivers and harbors was in the neighborhood of $33,000,000. In 1913, it was about $38,000,000. If then, the River and Harbor Bill of this session passes carrying appropriations of $20,000,000, there will be $72,000,000 available for river and harbor work in the treasury, or enough to carry the work onward for two years at the same rate of progress as in the year 1913. On the face of these figures there can be no question that the government is providing sufficient money for river and harbor improvement to carry on all works that can be justified on the ground that they render a public benefit proportionate to their cost.

Bringing Spanish-American Students to United States Engineering Schools

A correspondent in last week's issue,, discussing the prospects for American engineers and manufacturers in South America, suggests that a large proportion of the young men from the wealthy families of Argentine finish their education in the schools and colleges of France and traced to this influence the tendency in Buenos Aires to give preference to French styles of architecture and French methods of engineering work.

It is well known that South America has been always more closely in touch with Europe than with the United States. The similarity in language and in customs has something to do, doubtless, in attracting South Americans going abroad for an education to the Continent, rather than to the United States. To those who are to study engineering, however, there can be little doubt that the training they could obtain at a first-class engineering school in the United States would be much more valuable than that given in European schools. These naturally follow European practice and methods which are not as well adapted to American conditions as practice in the United States. Besides this, the advantage to Spanish-American students in studying engineering and acquiring a command of the English language is an advantage of great importance, since it makes available to them the largest volume of professional literature.

It would seem well worth while for American engineering schools to make a distinct effort at this time to attract students from South and Central America. Engineers who obtain their education here and become familiar with American methods and commercial customs, will be much more apt to use American methods, materials and machinery on their return to their native land to take up actual work, than they would had they been educated in Europe. It is true that in the past a considerable number of Spanish-American students have come to some of the American engineering schools, notably to Rensselaer and to Cornell. As far as we are aware, however, no special effort to bring students from foreign countries to the United States has ever been made, and it would seem well worth while for some of our leading schools to seek coöperation with the newly organized Bureau of Foregn Trade, in order to make their facilities and the advantages they offer more widely known in the countries to the south. Nor need this effort to obtain foregn students, with a far look to the future of American trade, be confined to the New World. With the difficult conditions which may continue in Europe for some time to come, it should be possible to divert to the United States numerous students from Russia, China, South Africa, and other lands. China, indeed, is already sending large numbers of students here. The great favor in which the United States is held in China is partly the result of the work of our missionaries there, and also of our fair treatment of the Chinese nation in connection with the Boxer war indemnity. The latter especially has a most favorable influence upon the development of our future commercial relations with that vast country.

The Winnipeg Municipal Electric Plant

The valuable article published elsewhere in this issue describing the results obtained by the City of Winnipeg with its new municipal electric-lighting plant deserves the careful study of engineers interested in the current discussion concerning the possibility of American municipalities supplying their own citizens with electric current for lighting and power purposes.

The City of Winnipeg has built a hydro-electric plant which now develops 22,500 hp. and will eventually be increased to 100,000 hp., transmitting the current gener-

ated 77 miles and distributing it to consumers at a maximum price of substantially 3c. per kw.-hr. Large consumers of power can obtain current at as low a rate as ½c. per kw.-hr. One can imagine the popularity of the municipal plant with the citizens and the commercial interests of Winnipeg from the statement that no longer ago than 1906 the base rate per kw.-hr. for electric current furnished by a private company was 20c.

It is of interest to observe the financial situation of Winnipeg's great experiment in municipal electric generation and distribution. While the plant has the great advantage of generating electric-current from water power so that the item of fuel is eliminated, it has to stand the heavy capital cost due to the investment in the long-distance transmission line and also due to the fact that a large part of its plant has been constructed for the ultimate development of 100,000 hp. eventually to be furnished, while it has so far been operating with a maximum capacity of less than one-fourth this. Added to this is the necessity the plant has been under of building up and organizing its business to make it a going concern.

Notwithstanding these heavy handicaps, the Winnipeg plant for the fiscal year ending Apr. 30, 1914, showed a profit of something over $60,000, after paying all operating expenses and fixed charges. It has now reduced the accumulated deficit from the first two years of partial operation to only $82,000. The city is now enlarging its hydro-electric plant to develop 50,000 hp. If it can sell a fair proportion of this additional capacity, the enterprise should be placed on a very lucrative basis with the present rates to consumers.

Winnipeg experience is not without a certain bearing on the probabilities of success of the Cleveland municipal electric plant described in our issue of July 30 last. If Winnipeg can carry on this municipal plant at a profit, there seems good reason to believe that Cleveland can do the same. Reference to our description of the Cleveland plant will show that with the high fuel economy which the Cleveland plant is designed to secure, the cost of the coal burned per kilowatt of output is after all a very small proportion of the operating expenses and would be nearly offset, it is probable, by the much higher fixed charges on the Winnipeg plant due to the cost of the long transmission line and the water-power development.

The Harlem River Tunnel

The successful sinking last week of the last section of the tubes for the Harlem River Tunnel, on the line of the Lexington Avenue Subway, New York City, is an event of especial interest to engineers. As most of our readers are aware, this tunnel is being built by substantially the same process that was adopted in building the Michigan Central Tunnel under the Detroit River two years ago, and which was fully described in ENGINEERING NEWS at the time.

The process consists, in brief, of building successive sections of steel tubes somewhat larger in diameter than the completed tunnel, framing them together, closing the ends of the tubes by temporary bulkheads so that they will float, sinking the sections one after the other in a trench dredged along the line of the completed tunnel, and filling with concrete, deposited under water through a tremie, the space below, around and over these steel tubes. The final stage of the process is to pump out from the interior of the tubes the water which had been admitted when the tubes were sunk, and place a concrete lining inside.

The various details of the process were worked out with great care at Detroit, and the work was considered entirely successful from the point of view of practical construction. In building the Harlem River Tunnel, however, the contractors and engineers have had the advantage of the experience gained at Detroit and have facilitated the work by improvements in numerous particulars. The work at the Harlem River is easier than that at Detroit on some accounts as the depth of water is less and there is no current in the river at slack tides. There are, however, four parallel tunnels necessary for the Harlem River, as compared with the two at Detroit. The Harlem River Tunnel is much shorter than the Detroit tunnel, the width of the Harlem River between bulkheads being only 600 ft. Nevertheless, the successful completion of this second tunnel will give engineers renewed confidence in this system of constructing under-river tunnels.

One very important advantage of this system from the operating point of view over a tunnel driven with hydraulic shields is that the roof of the tunnel can be placed much closer to the bed of the river, thereby reducing the vertical distance which the train must descend in order to make the under-river crossing. The top of the Harlem River Tunnel structure is only 7 ft. lower than the original river bed.

Another consideration which appeals very strongly to engineers and contractors is the comparative security and certainty of the process. There is always more or less risk in driving tunnels under rivers with the hydraulic shield. The use of compressed air is almost invariably essential, and the pressures are apt to be carried so high that more or less cases of injury to workmen occur, which under the present Employers' Liability Laws mean a very heavy bill of expense to the contractor. The rapid work possible with the system is illustrated by the fact that while the Harlem River contract was signed July 23, 1912, the contractors, the Arthur McMullen & Hoff Co., have sunk the last section, as noted above, have incased in concrete the four sections previously sunk and are placing the inside lining; the contract date for completion is early in 1916; but the work is already more than two-thirds done.

When the system was first proposed for the Detroit tunnel, there was much skepticism as to the possible risk in sinking the successive sections of the tubes, and as to other features in connection with the work. Experience at Detroit and at the Harlem, however, has now fully established that the claims of the able engineers who originated and developed this process were sound; and where the local conditions are such as to favor its use, it will probably be largely adopted in the future in preference to work with the hydraulic shield.

The Wood-Preserving Industry and the Supply of Creosote Oil

The sudden reduction in the supply of creosote oil from Europe as a result of the war is a matter of much importance to the wood-preserving industry. A special report upon the situation has just been prepared by

Clyde H. Teesdale, of the forest products laboratory at Madison, Wis., under the Department of Agriculture. According to Dr. Teesdale's figures, there are in the United States 94 wood-preserving plants, with an aggregate annual capacity of over 300,000,000 cu.ft. of timber. These plants actually treated 153,000,000 cu.ft. of timber in 1913. About two-thirds of this timber was treated with creosote, and most of the remainder with zinc chloride. In round numbers, these plants used a total of over 108,000,000 gal. of creosote oil, of which about 42,000,000 gal. were produced in the United States, and about 67,000,000 gal. were imported, principally from Germany and England. The supply from Germany has been entirely cut off, and for a time the English supply was also interrupted. It is likely, however, that the English supply will be reëstablished, and it may even be increased, since the English producers will lose a part of their market elsewhere.

On the assumption that the foreign supply of creosote to the United States will be seriously curtailed, Dr. Teesdale points out that the output of the timber-preserving works can be maintained either by adopting the zinc chloride instead of the creosote process of treatment, or by using the so called "empty-cell" process of creosoting, by which the consumption of creosote oil per cu.ft. is reduced to 5 to 7 lb. instead of 10 or 12 lb. It is also possible to use a mixture of creosote and zinc chloride, for which only about 3 lb. of creosote per cu.ft. of timber is required, and in fact, 8,000,000 cu.ft. of timber were treated by this combined process in 1913.

Other possibilities suggested by Dr. Teesdale are the use of creosote made from water-gas tar (most of which has hitherto been either burned or thrown away), the use of creosote and crude petroleum, the use of creosote made from wood tar, and the use of sodium fluoride. The last process has been experimented with successfully in Europe, and tests of ties treated with it are under way in the United States.

Another possible source of economy in creosote is reviewed by F. R. Church in an article published on another page of this issue, consisting in mixing refined tar with the creosote. This process, in fact, is already widely used.

Another factor which will tend to help out the wood-preserving situation is likely to be a falling off in the amount of timber creosoted. This will certainly happen should there be any large increase in the price of wood-preserving materials, but apart from that there will be probably in the coming year a comparative slackening in the demand for timber of all classes, on account of the falling off in construction work which is already apparent. Further, as we have already pointed out, the tendency of engineers will be to carry on their construction work at the lowest possible first cost, on account of the high interest rates likely to prevail, so that timber construction will be used in many cases without going to the expense of wood preservation.

The American railway-tie-preserving plants will probably continue with little slackening, as the work they are engaged on is necessary for regular railway maintenance. It is probable, however, that from English sources a considerable part of the deficit produced by the stoppage of German imports of creosote oil can be made up; and a falling off in the demand for preserving other classes of timber, with the use of some of the other processes suggested by Mr. Teesdale, will probably be sufficient to bring about an equilibrium in the industry.

Letters to the Editor

Graphite and Boiler Scale

Sir—Your issue of July 30, '14, contains an article on "Graphite Treatment for Boiler Scale" in which a good many claims are made for this method of removal of scale. The one which attracted my attention is that the graphite is noncorrosive and harmless. In this connection, I would like to refer you to the tests of boiler compounds made by the U. S. Government, under the direction of Lieut. Commander Frank Lyon. In the *Journal* of the American Society of Naval Engineers, November, 1911, p. 1080, he states: "Graphite is a scale remover for the same reason that hydrochloric acid is. That is, it corrodes the metal underneath the scale and frees the scale from the metallic surfaces." The tests referred to above extended over a period of years and should be authoratative.

The use of boiler compounds is at best a makeshift method and in permanent steam plants seems to be due to the false conception of many that eleventh hour cures are cheaper than other apparently more expensive installations for treating water outside the boiler. The waste of fuel is well known and the harmfulness of scale to the structural condition of the boiler does not need repetition here, but it seems a little strange that we have so little discussion of the scientific management of boilers. The ordinary boiler is designed to generate steam and is not intended to be used as a retort for chemical experiment.

P. M. LaBach,
Assistant Engineer, Chicago, Rock Island & Pacific Ry.
803 La Salle Station, Chicago, Aug. 30, 1914.

†Commander Lyon's tests were chemical-laboratory studies of certain chemical reagents which were being introduced to make boiler water alkaline or to render insoluble under heat the scale-forming constituents in feed water. The same experiments were applied to graphite though obviously it cannot act in either of these ways, being entirely a mechanical assistant. For instance, pieces of boiler plate were filed bright and immersed 2 in. for one and for 30 days in distilled water (200 c.c.) containing divers amounts of the various reagents—the latter being varied to find the anticorrosive concentrations. The tops of jars were left open for natural absorption of air and CO_2. Graphite not acting as a regeant, in spite of Commander Lyon's assertion that its nature is that of hydrochloric acid, yields no significant data under this experi-

mentation. Optimum conditions were present for stimulating corrosion of the iron samples. In a boiler there would prevail vastly different conditions; the lack of air, the changed chemical equilibria due to new temperature and pressure, the lack of initial bright iron surface to join contact with the carbon, etc., make it unsafe to prophesy from these studies as to what would happen in a boiler. Similar studies have "proved" that graphite and lampblack would be unmitigated evils in paint—but they continue to give at least fair protection where any oil paint would serve.

Commander Lyon made further accelerated and intensified tests of boiler compounds under more natural conditions in boiler tubes, but nothing was reported about graphite and indeed little vital information was to be expected if the action of graphite is mechanical and slow.

In regard to the general use of compounds in boilers referred to in the last paragraph of the above letter, we venture to suggest that it may be a question of economics. There is nothing holy about the inside of a boiler to forbid chemical action and if it is cheaper to combine boiler and chemical tank it will be done. Experience seems to show that where there is present in the supply only 5 to 10 grains per gallon of scale-forming constituents, the separate water-treating plant can show no economy.—Ed.]

Bridges over the New York Barge Canal

Sir: In your issue of Sept. 10, 1914, you published a letter from Mr. John Reid, 17 Battery Place, New York City, with the heading "Boat Design Difficulties on the New York State Barge Canal."

In this letter, Mr. Reid criticizes J. A. Bensel, State Engineer and Surveyor, for not providing greater headroom under the fixed bridges that have been constructed over the Barge Canal under the authority given to him principally by Chapter 147, Laws of 1903.

It has been the privilege of the writer to serve under Mr. Bensel for the past three years, and I feel it my duty to explain to Mr. Reid that the above mentioned chapter provides: "All fixed bridges and lift bridges when raised shall give a clear passageway of not less than 15½ ft. between the bridge and the water at its highest ordinary navigable stage."

The funds available for this work do not provide a sufficient amount to place as many fixed bridges as are necessary. The cost of bascule bridges is therefore prohibitive.

The above mentioned law also provides a bottom width of 75 ft. and a depth of channel of 12 ft., where a new location has been made or where the old location was enlarged. These dimensions, however, apply only to the land line and affect about 30% of the total length of canal, the remaining part of the line being located in natural river or lake channels where a width of channel of 200 ft. or more will be available for navigation.

The State of New York has authorized an expenditure of $101,000,000 for the improvement of the Erie, Champlain and Oswego Canals, to accommodate barges of 1000 tons capacity. The canal that is now nearing completion under the able leadership of the present State Engineer and Surveyor, will accommodate vessels of about 3000 tons capacity and it seems to me that this fact should be better known and appreciated by the public in general and by all naval architects in particular.

W. H. Yates,

Albany, N. Y., Sept. 17, 1914.

Lessons from Difficulties in Initial Operation of High-Tension Transmission Lines

Sir—Referring to the article by F. G. Allen on "Difficulties in Initial Operation of 110,000-Volt Transmission Line," in your issue of Aug. 20, the author is entitled to the thanks of the profession for furnishing information on details too frequently omitted from the published accounts of such construction. It would be of great assistance to the designers of transmission lines if more publicity were given to the actual results obtained in service.

Although the relative value of some of the details of construction is difficult to ascertain, such information is very greatly to be desired. A detail which gives entire satisfaction in service is well worth an excess of cost over that of a somewhat unsatisfactory detail. This feature was evidently given consideration, since it is stated by the author that two ground wires were used, and that the structures were heavier than many of those heretofore installed. Further, it would appear, from the lack of insulator failures, that the two ground wires have presumably given adequate protection to the line. However, it would be of interest to know whether, other conditions being equal, the line with two ground wires has had less failures during a given period than neighboring lines with but one ground wire.

In case the power conductors are copper wires, with, in most localities, an indefinitely long life, it is possible that a greater ultimate benefit would be obtained for about the same original expenditure if one copper cable or a copper-covered cable were used as a ground wire, instead of, as has sometimes been the case, two galvanized-steel cables.

It was probably not so intended by the author, but the inference might be made that suspension-type insulators were, *per se*, more desirable than pin insulators for the telephone wires. It would seem that the telephone wires could have been carried successfully on high-tension pin insulators, and by transposing them in every span, or in every few spans, that the inductive troubles should have been considerably reduced.

R. D. Coombs,
Consulting Engineer.

30 Church St., New York City, Aug. 21, 1914.

Sir—Answering R. D. Coombs' letter of Aug. 21, we beg to advise as follows:

It would hardly be logical to state that two ground wires afford better protection than one wire, as there is no other high-tension line paralleling the Tallulah line, and to compare the results of operation of this line with some other line would not be proper because of different local conditions. It might be interesting to note, however, that the Tallulah line has been struck by lightning three times, and the lightning in each case stripped the

insulators of their skirts, but when voltage was again placed on the line, the insulators stood up O. K. without puncturing. This would lead one to believe that the ground wires are not a perfect protection. However, we do not feel that we have compiled, as yet, sufficient data to speak of the absolute efficiency of overhead ground wires.

As to the question of using copper-clad cable for ground wires, or one copper-clad cable instead of two steel ground wires, such construction has been contemplated in view of the fact that the life of the ground wire should be the equal of that of the power conductors. On the other hand, the steel in the towers is only galvanized. There is no question about the life of the ordinary steel ground wire being greater than that of the towers themselves, and it is probable that during the life of any steel towers now constructed, more definite information will have been learned regarding the merits of overhead ground wires for lightning protection, the result of which may be the discontinuance of their use.

As to the last paragraph of Mr. Coombs' letter regarding the use of suspension insulators on the telephone lines, the suspension type of insulator was decided upon instead of a higher-voltage pin-type because the method of construction made it easier to make a change of this kind, and the additional advantage was obtained of being easily able to add a second suspension insulator should it be necessary to further raise the insulation of the line.

The telephone lines are transposed at each and every tower, but this only keeps down the voltage between the two wires and prevents unbalanced potential, and does not reduce the voltage induced between the telephone wires and the ground by the voltage on the power conductors. This induced voltage to ground under normal operating conditions is about 5600 volts, but is considerably reduced by the installation of drainage coils, specially designed for the purpose, between the telephone lines and ground. Tests made on the telephone lines under special conditions showed an induced voltage to ground of some 18,000 volts, and under surges set up by lightning or switching on the proper conductors, insulators on the telephone lines which were tested to 70,000 volts have punctured, as the drainage coils do not protect the equipment from steep-front oscillating waves.

CHAS. O. LENZ, Chief Engineer.
BY FRANK G. ALLEN, Secretary.

Georgia Ry. & Power Co.,
71 Broadway, New York City, Sept. 2, 1914.

NOTES AND QUERIES

Track Layouts at Stations (Correction)—In this article in our issue of July 9 there was an error in the 14th line of second column, page 57. Tracks (A) and (C) are kept clear, and not (A) and (B), as stated.

In the article on the "Irrigation Operations of Imperial Water Co. No. 1 for the Year 1913," published in our issue of Sept. 3, 1914, p. 495, the full address of Ray S. Carberry, Superintendent of the company, was not given. As many of our readers may be interested in securing from Mr. Carberry a copy of his complete report, we would advise that he is located at Imperial, Calif.

The Mountain Parks of Denver, Colo., are to be increased by the addition of 30,040 acres ceded to the city by the Federal government without cost to the city by a recent act of Congress which has just been signed by President Wilson.

Another Municipal Electric Plant Supplying Lighting Current at 3 cents per Kw.-Hr.

BY R. A. SARA*

In ENGINEERING NEWS, July 30, 1914, an article on "Cleveland's New Municipal Electric Plant," states that

> Cleveland is the only city in the United States or anywhere else, for that matter, as far as we are aware, where a municipal electric plant furnishes electric current at a maximum rate of 3c. per kw.-hr.

Charles F. Roland, Industrial Commissioner of Winnipeg, population 210,000, has asked me to forward details of the Winnipeg municipal plant which, since October, 1911, has been selling electric current in Winnipeg at a maximum net rate of 3c. per kw.-hr. Large consumers buy power as low as ½c. net and commercial lighting is as low as 1¼c. net. The rate system may be outlined as follows:

SCHEDULE B: Residence Lighting, 3¼c. per kw.-hr., subject to a net minimum monthly payment of 50c. per meter.

The city allows a discount of 10% on all bills paid within ten days.

SCHEDULE A: Commercial lighting, 3¼c. per kw.-hr., subject to a net minimum monthly payment of $1 per kw. of total connected load, but in no case less than $1 net per month per meter. Prompt payment discounts: One year contract, 10%; three-year contract, 15%; five-year contract, 20%. Wholesale discounts on gross bills over $25 per month:

	Per cent. discount
For the first $25	None
For the second $25	20
For the next $50	25
For the next $50	30
For the next $50	35
For the next $50	40
From $250 to $500	50
Excess over $500	60

SCHEDULE E: Heating, 1c. per kw.-hr., subject to a net minimum monthly payment of 75c. per kw. total connected load, but in no case less than 75c. net per month per meter. (Where connected load is greatly in excess of maximum demand the city will install an automatic cutoff and base the monthly minimum charge on specified load at which the cutoff is set.)

Prompt payment discount, one-year contract 10%.

SCHEDULE C: Alternating-current power,

	Cents per kw.-hr.
First 50 hours per month use of total connected load	3¼
Next 50 hours per month use of total connected load	2.5
Next 50 hours per month use of total connected load	1.9
Next 50 hours per month use of total connected load	1.4
Next 50 hours per month use of total connected load	1.1
Excess over 250 hours per month use of total connected load	0.8

Subject to minimum monthly payment of 75c. per hp. of total connected load but in no case less than $1 net per month per meter. Prompt-payment discounts: One-year contract, 10%; three-year contract, 15%; five-year contract, 20%.

Wholesale discounts apply on gross bills of over $100 per month.

	Per cent. discount
For the first $100	None
For the second $100	10
For the third $100	20
For the fourth $100	30
For the fifth $100	40
From $500 to $1000	50
Excess over $1000	60

SCHEDULE F. Direct-current power.

	Cents per kw.-hr.
First 50 hours' use per month of total connected load	3¼
Next 50 hours' use per month of total connected load	2.5
Next 50 hours' use per month of total connected load	1.9
Next 50 hours' use per month of total connected load	1.4
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*Sales Manager, City Light and Power Department, Winnipeg, Man.

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It would hardly be logical to state that two ground wires afford better protection than one wire, as there is no other high-tension line paralleling the Tallulah line, and to compare the results of operation of this line with some other line would not be proper because of different local conditions. It might be interesting to note, however, that the Tallulah line has been struck by lightning three times, and the lightning in each case stripped the

insulators of their skirts, but when voltage was again placed on the line, the insulators stood up O. K. without puncturing. This would lead one to believe that the ground wires are not a perfect protection. However, we do not feel that we have compiled, as yet, sufficient data to speak of the absolute efficiency of overhead ground wires.

As to the question of using copper-clad cable for ground wires, or one copper-clad cable instead of two steel ground wires, such construction has been contemplated in view of the fact that the life of the ground wire should be the equal of that of the power conductors. On the other hand, the steel in the towers is only galvanized. There is no question about the life of the ordinary steel ground wire being greater than that of the towers themselves, and it is probable that during the life of any steel towers now constructed, more definite information will have been learned regarding the merits of overhead ground wires for lightning protection, the result of which may be the discontinuance of their use.

As to the last paragraph of Mr. Coombs' letter regarding the use of suspension insulators on the telephone lines, the suspension type of insulator was decided upon instead of a higher-voltage pin-type because the method of construction made it easier to make a change of this kind, and the additional advantage was obtained of being easily able to add a second suspension insulator should it be necessary to further raise the insulation of the line.

The telephone lines are transposed at each and every tower, but this only keeps down the voltage between the two wires and prevents unbalanced potential, and does not reduce the voltage induced between the telephone wires and the ground by the voltage on the power conductors. This induced voltage to ground under normal operating conditions is about 5600 volts, but is considerably reduced by the installation of drainage coils, specially designed for the purpose, between the telephone lines and ground. Tests made on the telephone lines under special conditions showed an induced voltage to ground of some 18,000 volts, and under surges set up by lightning or switching on the proper conductors, insulators on the telephone lines which were tested to 70,000 volts have punctured, as the drainage coils do not protect the equipment from steep-front oscillating waves.

CHAS. O. LENZ, Chief Engineer.
BY FRANK G. ALLEN, Secretary.
Georgia Ry. & Power Co.,
71 Broadway, New York City, Sept. 2, 1914.

NOTES AND QUERIES

Track Layouts at Stations (Correction)—In this article in our issue of July 9 there was an error in the 14th line of second column, page 57. Tracks (A) and (C) are kept clear, and not (A) and (B), as stated.

In the article on the "Irrigation Operations of Imperial Water Co. No. 1 for the Year 1913," published in our issue of Sept. 3, 1914, p. 495, the full address of Ray S. Carberry, Superintendent of the company, was not given. As many of our readers may be interested in securing from Mr. Carberry a copy of his complete report, we would advise that he is located at Imperial, Calif.

The Mountain Parks of Denver, Colo., are to be increased by the addition of 30,040 acres ceded to the city by the Federal government without cost to the city by a recent act of Congress which has just been signed by President Wilson.

Another Municipal Electric Plant Supplying Lighting Current at 3 cents per Kw.-Hr.

BY R. A. SARA*

In ENGINEERING NEWS, July 30, 1914, an article on "Cleveland's New Municipal Electric Plant," states that

> Cleveland is the only city in the United States or anywhere else, for that matter, as far as we are aware, where a municipal electric plant furnishes electric current at a maximum rate of 3c. per kw.-hr.

Charles F. Roland, Industrial Commissioner of Winnipeg, population 210,000, has asked me to forward details of the Winnipeg municipal plant which, since October, 1911, has been selling electric current in Winnipeg at a maximum net rate of 3c. per kw.-hr. Large consumers buy power as low as ½c. net and commercial lighting is as low as 1¼c. net. The rate system may be outlined as follows:

SCHEDULE B: Residence Lighting, 3¼c. per kw.-hr., subject to a net minimum monthly payment of 50c. per meter.

The city allows a discount of 10% on all bills paid within ten days.

SCHEDULE A: Commercial lighting, 3¼c. per kw.-hr., subject to a net minimum monthly payment of $1 per kw. of total connected load, but in no case less than $1 net per month per meter. Prompt payment discounts: One year contract, 10%; three-year contract, 15%; five-year contract, 20%. Wholesale discounts on gross bills over $25 per month:

	Per cent. discount
For the first $25	None
For the second $25	20
For the next $50	25
For the next $50	30
For the next $50	35
For the next $50	40
From $250 to $500	50
Excess over $500	60

SCHEDULE E: Heating, 1c. per kw.-hr., subject to a net minimum monthly payment of 75c. per kw. total connected load, but in no case less than 75c. net per month per meter. (Where connected load is greatly in excess of maximum demand the city will install an automatic cutoff and base the monthly minimum charge on specified load at which the cutoff is set.)

Prompt payment discount, one-year contract 10%.

SCHEDULE C: Alternating-current power,

	Cents per kw.-hr.
First 50 hours per month use of total connected load	3¼
Next 50 hours per month use of total connected load	2.5
Next 50 hours per month use of total connected load	1.9
Next 50 hours per month use of total connected load	1.4
Next 50 hours per month use of total connected load	1.1
Excess over 250 hours per month use of total connected load	0.8

Subject to minimum monthly payment of 75c. per hp. of total connected load but in no case less than $1 net per month per meter. Prompt-payment discounts: One-year contract, 10%; three-year contract, 15%; five-year contract, 20%.

Wholesale discounts apply on gross bills of over $100 per month.

	Per cent. discount
For the first $100	None
For the second $100	10
For the third $100	20
For the fourth $100	30
For the fifth $100	40
From $500 to $1000	50
Excess over $1000	60

SCHEDULE F. Direct-current power.

	Cents per kw.-hr.
First 50 hours' use per month of total connected load	3¼
Next 50 hours' use per month of total connected load	2.5
Next 50 hours' use per month of total connected load	1.9
Next 50 hours' use per month of total connected load	1.4
Next 50 hours' use per month of total connected load	1.1
Excess over 250 hours' use per month of total connected load	0.8

*Sales Manager, City Light and Power Department, Winnipeg, Man.

Subject to a net minimum monthly payment of 75c. per hp. of total connected load but in no case less than $1 net per month per meter.

Prompt payment discounts: One-year contract, 10%; three-year contract, 15%; five-year contract, 20%.

Schedule E applies where separate circuits are provided. The low rate, 0.9c. net, has encouraged electric cooking to such an extent that over 1000 electric stoves are in use.

The effect of the municipal service on electric rates in Winnipeg is thus shown:

	Per kw.-hr. base rate
1906	2c
1907	1c
1911	7½
1912	3½

Construction commenced in 1906 and operation in October, 1911. The generating station is situated at Point du Bois on the Winnipeg River, 77 miles from Winnipeg, where a 46-ft. head is available.* The total power available at the site is 100,000 hp. The original development included dams, forebay, head-gates, etc., for the full amount, but only 22,500 hp. capacity was installed. This is now being increased to 50,000 hp., and the remainder may be developed at any time by extending the power-house building and installing water-wheels, generators and transformers.

Current is transmitted to Winnipeg at 60,000 volts over a double-circuit aluminum-conductor steel-tower transmission line situated on a 100-ft. right-of-way. It is stepped down at the terminal receiving station to 12,000 volts and distributed underground to the substations located conveniently around the city.

The expenditure on the original development was as follows:

(1) Hydro-electric plant and generating station	$2,336,195.00
(2) Transmission line and terminal receiving station	1,390,486.30
(3) Distributing system	2,012,796.79
Total	$5,739,478.09

This has since been increased to $6,724,372.58 (April 30, 1914) by additions to the plant and extensions of the distribution system. Progress made may be summarized in part as follows:

Period	Net gain in number of meters in service	Kw.-hr. generated	Gross billings	Net profit or loss
Period from Oct. 1911 to Apr. 30, '12	6,686	7,071,735		$58,841.74 Loss
First fiscal year May 1, '12 to Apr. 30, '13	15,038	39,071,750	$638,081.73	83,432.90 Loss
Sec. fiscal year May 1, '13 to Apr. 30, '14	7,039	60,271,385	953,882.88	60,222.61 Profit
Total	28,763			$81,917.09 Loss

The plant was operated at a loss during the first year and a half because during that period the business connected up was not sufficient, at the rates prevailing, to pay all charges although 21,724 meters were connected in that time. The present low rates were made at the commencement of operation as it was realized that the lower the rates, consistent with cost, the quicker the load would be secured. It is safe to say that the deficit will be entirely repaid out of profits early in 1915.

The accounts are kept according to forms prescribed by the Public Utility Commission of the Province of Manitoba, which periodically audits the books and stipulates what provision shall be made for depreciation, etc. The financial statements have been approved by this Commission.

*Described in "Engineering News," July 4, 1912.

INCOME AND EXPENSE ACCOUNTS, WINNIPEG MUNICIPAL ELECTRIC PLANT, FISCAL YEARS ENDING APR. 30, 1913, AND 1914

	1913	1914
Operating Revenues		
Domestic and commercial lighting and heating	$286,437.50	$512,542.94
Commercial power	71,954.59	218,643.06
Municipal street lighting	28,921.94	58,777.98
Municipal building lighting	13,662.35	6,820.16
Municipal power, water-works	64,198.27	59,481.58
Municipal power—miscellaneous	2,467.82	1,575.00
Tramway earnings	6,649.13	7,964.47
Accounts receivable	70,444.43	.....
Total	$544,736.03	$865,805.19
Operating Expenses		
Power	$25,616.70	$28,732.36
Transmission and transformation	37,573.81	45,875.34
Distribution	41,969.76	37,861.49
Consumption	6,947.14	9,009.47
Commercial	64,701.54	67,333.27
General	17,079.15	22,725.81
Tramway	17,035.58	21,161.93
Undisturbed	34,085.47	22,584.42
Contingencies, extraordinary	.....	2,282.49
Depreciation	99,662.32	229,435.24
Taxes	3,045.93	3,580.24
Total	$347,717.40	$490,582.06
Net operating revenues	$197,018.63	$375,223.13
Nonoperating revenues	908.15	1,816.28
Income	$197,926.78	$377,039.41
Deductions from income:		
Interest on founded debt	$210,649.55	$270,681.08
Interest on floating debt	70,575.19	24,460.37
Deficit for year	$83,297.96	.....
Surplus for year	.....	$81,897.96
Applied to equipment and stores	.....	21,675.35
Deficit, beginning of year	58,841.74	142,139.70
Deficit, end of year	$142,139.70	$81,917.09

Annual Convention of the National Paving Brick Manufacturers Association; Inspection Tour of Brick Roads*

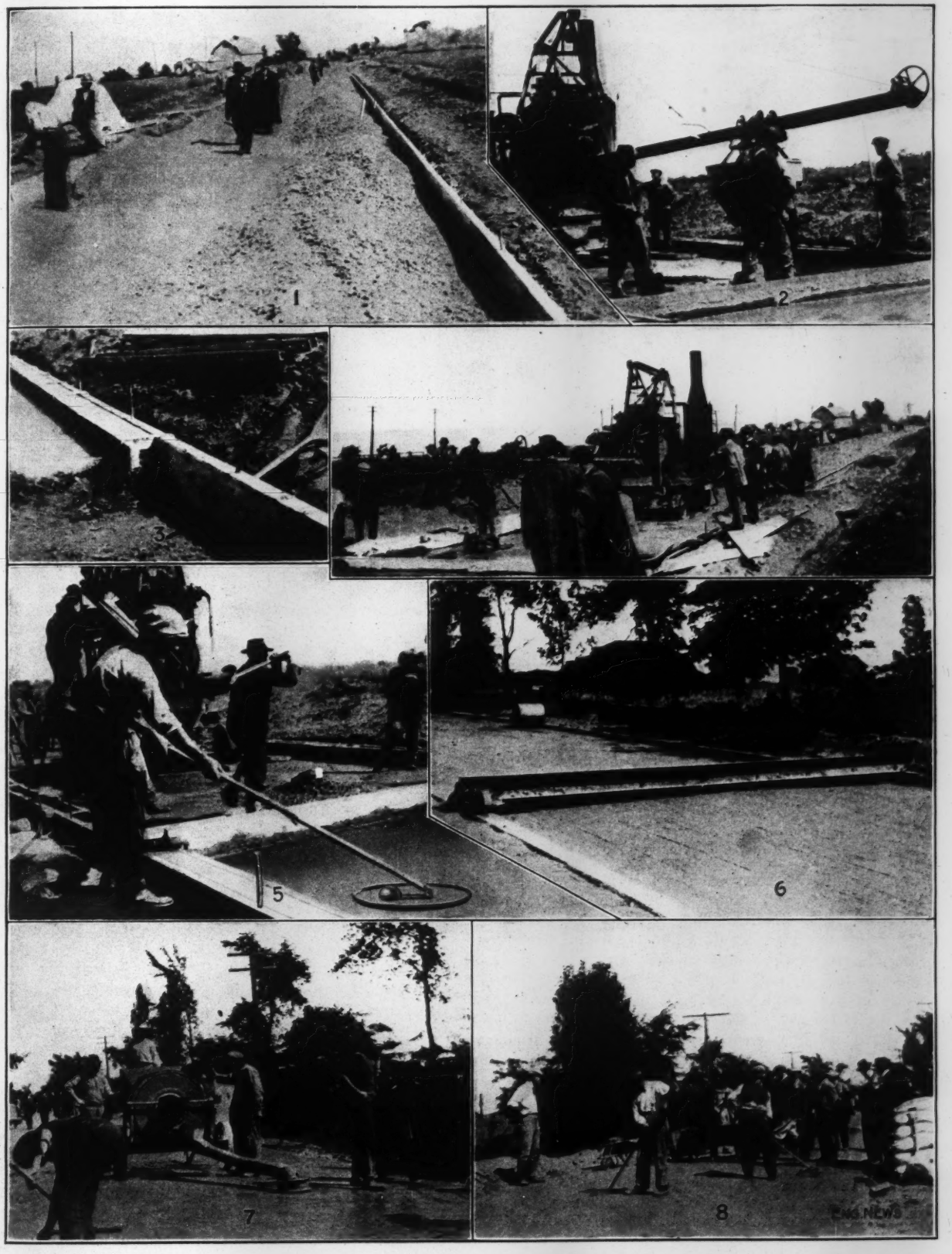
Two days of the annual convention of the National Paving Brick Manufacturers Association, held in Buffalo, Sept. 9-11, were devoted to automobile inspection tours over brick roads, both completed and in various stages of construction. As guests on these trips the Association had many city and highway engineers and professors of civil engineering from the Eastern States, where as a general thing brick country roads are rather the exception.

On leaving Buffalo to the southwest many brick-paved streets were inspected which had several years' service to their credit. From city streets the trip was continued on over brick country roads almost without a break.

Having seen several brick roads three and four years old, the party disembarked at State Road No. 5407, where a brick pavement 5.92 miles long is in the process of construction. This road is a good example of the highest class of New York State road work. This piece of construction includes several thousand feet of new alignment. The pavement is made 16 ft. wide on a 5-in. (minimum 5-in.; 7-in. in center) concrete base, mixed 1:2-½:5. The contractor is the Louis H. Gipp Construction Co., of Buffalo, and the brick used are of the wire-cut-lug variety.

The accompanying illustrations show all phases of the pavement work but laying and rolling the brick. After the subgrade is prepared and rolled the stone and sand for the concrete are piled directly on it. Just the right quantities are distributed either side of the mixer so

*For report of annual meeting see "Engineering News," Sept. 17, 1914, p. 605.



CONSTRUCTION VIEWS OF A FIRST-CLASS BRICK ROAD, NEW YORK STATE HIGHWAY DEPARTMENT, HAMBURG, N. Y.

that the passage of the mixer uses up all the material, leaving the subgrade ready to receive the concrete.

The forms to support the concrete base and edging* consist of 10-in. channels, properly aligned and held in place by ½-in. round iron rods driven through holes in the flanges about every 3 ft. Between these 10-in. channels the concrete foundation is laid 5 in. deep, and then a 2x6-in. plank is laid on edge on the base, separated from the channel by 6-in. wood struts, which are knocked out as the work of filling progresses (Fig. 3). The plank and channel are held together by strap irons or brackets, which are quickly lifted off and the forms removed as soon as the concrete has sufficiently set.

Figs. 2 and 4 show the concreting in progress. After the base is struck off and given its proper crown by means of a board screed or float, it is smoothed with the implement shown in Fig. 5, which is a device worked up by the contractor. This consists of a sheet-iron disk, about 18 in. in diameter, with upturned or beaded edge. To the disk, about halfway between its center and its edge, is fastened a handle 8 or 10 ft. long by means of a universal joint. On the same diameter of the disk opposite the handle is a counterweight. Pushing the disk back and forth gives it a revolving as well as a sliding motion, which answers admirably for troweling.

Longitudinal expansion joints along the edging are provided, but no transverse joints. Each longitudinal expansion joint is 1 in. wide and is made by placing alongside each edging, wood strips with metal wedge pieces dropped over the tops of the boards, and between the board and the edging, every 3 ft.

Fig. 6 shows a steel sand spreader for smoothing and crowning the sand cushion; and Fig. 7 shows the first filling of the joints with a very wet grout, after which the pavement is gone over with a thicker grout, having the consistency of cream (Fig. 8), which is spread and pushed into the joints with squeegees.

After the grouting has been completed and the joints filled flush with the tops of the brick and the grout sufficiently hardened so that the sand will not absorb moisture from the grout, a ½-in. layer of sand or gravel is spread over the pavement and kept moist for at least 10 days, to insure a proper curing of the grout. The bituminous filler for expansion joints is placed as soon as the grout has set, and within 36 hr. of the time when the grout was applied.

Leaving this piece of work the inspection party continued to Hamburg, where an opportunity was given to examine the deleterious effects of transverse expansion joints in a brick pavement built in 1910. Further on, the resurfacing of a water-bound macadam road, built in 1907, was in progress. Here wire-cut-lug brick are being laid on a 3-in. concrete base, which is built on top of the old macadam.

The first day's trip was completed after a luncheon at the Roycroft Inn, East Aurora, by returning to Buffalo over a different route, which presented several excellent examples of recent brick-road construction.

The second day's trip was to the north, through Delaware Ave., Buffalo, to Niagara Falls. On this trip, also, much of the traveling was over brick pavements which had been in place from a few months to 20 years. In one continuous strip on the famous Niagara Boulevard is 17 miles of brick road, from the city line of Buffalo to the city line of Niagara Falls. This road cost $375,000 and is a splendid example of both repressed and wire-cut-lug brick pavement.

From the city of Niagara Falls the party continued to Lewiston and old Fort Niagara, returning to the International Hotel at Niagara Falls for lunch. Much of this road follows the famous old portage road of the French and Indian War period and is replete with historical associations. Long stretches of this road are also brick paved.

While the above itinerary probably would contain little new to city and highway engineers of the Middle West, where brick roads and street pavements have long been so favorably known, it was quite an education to many of the Eastern visitors. Buffalo and vicinity is probably as far east as brick country roads have yet been built on any very extensive scale.

*This edging is illustrated in "Engineering News" July 9, 1914, p. 87.

The Creosote Oil Situation and the Treatment of Crossties*

By S. R. Church†

Statistics compiled by the Forest Service of the United States Department of Agriculture in coöperation with the American Wood Preservers' Association, show that approximately 40 million crossties were treated during 1913, an increase of about 20% over 1912, and an increase of 100% over 1908. Of these, approximately 25 million were treated with creosote oil. Those thus treated probably required between 60,000,000 and 70,000,000 gal. of oil, or approximately two-thirds of the total creosote oil consumed during 1913.

The production of creosote oil in the United States for 1913 was, roughly, 40,000,000 gal., or less than 40% of the total consumption; and the balance of the oil, over 66,000,000 gal., was imported from Europe, principally from Germany and England. It is evident that no imports of oil from Germany can be expected for some time, particularly as a specific embargo has been laid upon such shipments by the German Government, and shipments from England are by no means to be counted upon.

This situation lends peculiar significance to the discussion on wood preservation that occurred at the meeting of the American Railway Engineering Association, when the report of the Committee on Wood Preservation was presented. This committee has realized for some time that the supply of high-grade creosote oil such as they have recommended and specified as "No. 1 Creosote Oil" was limited and inadequate, and they have for a number of years been investigating the merits of the use of refined coal tar in creosote oil.

Prior to the publication of this report, definite information was difficult to obtain, although it was recognized that many roads had adopted this practice. It was estimated by von Schrenk and Kammerer‡ that 40% of all the creosote oil used at present in the United States was a combination of coal tar and distillate oil. In addition

*This statement of the war's effect on the supply, with special reference to the treatment of railway crossties, was furnished by the Barrett Manufacturing Co., at our request. —Ed.

†Manager, Research Department, Barrett Manufacturing Co., 17 Battery Place, New York City.

‡"Use of Refined Coal-Tar in the Creosoting Industry," Proc. A. R. E. A., 1915.

to this summary of von Schrenk and Kammerer, a report was presented and printed in the *Proceedings* of the American Railway Engineering Association, p. 1074, by the writer, on tests made in December, 1913, at the plant of the Pittsburgh Wood Preserving Co. In these tests a direct comparison was made on eight different kinds of wood, of ordinary coal-tar creosote oil of No. 2 grade and a special grade of creosote oil containing filtered coal tar, prepared to meet the following specification:

The oil shall be a pure coal-tar product, containing no crude tar.
Water shall not exceed 2%.
Specific gravity at 38° C. 1.06 to 1.10.
Insoluble in hot benzol, not over 2%.
Distillation by standard method:
Not more than 1% at 170° C.;
" " " 5% " 210° C.;
" " " 30% " 235° C.;
" less " 40 nor more than 60% at 300° C.;
" " " 60% at 355° C.
Viscosity at 100° C., not more than 25 sec. for 100 c.c

Analyses of average samples of the oils used throughout the tests were given as follows:

	Regular Oil	Special Oil
Specific gravity at 38° C.	1.049	1.078
Water, per cent	0.30	0.30
Free carbon, per cent	0.31	1.00
Viscosity (100 c.c. Engler)		
at 60° C. (140° F.) sec.	25.5	28.6
at 100° C. (212° F.) sec.	23.8	24.4
Retort distillation:		
Total to 170° C., per cent	0.0	0.0
" " 200° "	1.7	1.5
" " 210° "	4.8	4.3
" " 235° "	37.8	28.7
" " 270° "	62.9	49.5
" " 315° "	76.3	59.4
" " 355° "	91.8	73.2

From the results of these tests it was determined that equally good penetration could be obtained with the special oil as with the regular oil under the same conditions of treatment, both by full-cell and empty-cell processes; the only difference was that the oil in the cylinder was maintained at an average of 15 to 20° higher during the treatment with the special oil.

If this discussion was pertinent and interesting to the railroads when presented, it certainly becomes of much greater importance in the light of the present shortage of creosote oil. It is recognized that the oil used in the Pittsburgh experiments contained approximately 30% of filtered coal tar, yet, owing to the care with which it was prepared and the elimination of free carbon by filtration, the oil was scarcely more viscous at the temperature of treatment than a straight distillate oil, and not only penetrated the ties equally well, but left a perfectly dry and unobjectionable surface of the timber employed.

These results could not, of course, be duplicated by indiscriminately mixing crude tar with creosote oil; but as Earl Stimson, Chairman of the Committee on Wood Preservation, indicated in presenting his report, the committee may be expected before very long to prepare definite specifications for such a product, under which the railways may use such oil with economy.

In view of the urgency of the present situation, and particularly in view of the natural increase in the price of high-grade creosote oil, the railways operating treating plants might well consider anticipating such a recommendation from the committee, and we have no doubt that the committee's experts, such as Dr. von Schrenk and Mr. Sterling, would be glad to recommend tentative specifications which might safely be used for all the work the roads might have.

Even should all the railways adopt this grade of oil there would still be a shortage; but conditions would certainly be very much relieved by such practice.

Sidelights on the Salem Conflagration *

The burning of 1600 buildings in Salem, Mass., in 13 hr. (June 25-26), devastating 253 acres of the business district at a loss of $14,000,000, is too important and too typical of like possibilities in other American cities to be passed over with a mere description of the damage, published immediately after the fire. No investigation was needed to discover that frame buildings are a continual invitation for this sort of disaster. One of the important recommendations in the bulletin is that the use of wood shingles be prohibited in all districts of a city.

Knowledge that the old wrought-iron and cement water mains were weak restricted the manipulation of the water-supply, although these mains did not burst until after the fire had spent its force. The abundant water-supplies of Peabody, Danvers and Beverly were gingerly tied into the Salem system, resulting in a hydrant pressure of 10 to 20 lb.

It would seem that the long campaign for standard fire hose and hydrant connections throughout the country, so logically based, would have met success ere now; but, as usual, in a conflagration of this character, the fire apparatus of some of the surrounding towns was rendered impotent through inability to connect to the water system.

The gasoline-driven fire engine was shown to be more mobile than the horse-drawn apparatus, and to be able to carry sufficient fuel for such a demand, instead of having to requisition wood fences and box boards.

The second recommendation made in this bulletin is for the establishment of a modern and reliable water-supply under adequate pressure, and well distributed post hydrants with standard connections.

The final recommendation bears upon the out-of-date fire department of Salem, which maintained no adequate inspection bureau. It states the need for proper municipal housekeeping under the administration of a commissioner or a fire chief possessing modern ideas and with authority to maintain cleanliness; regulating the storage and use of inflammables; and compelling the proper automatic fire protection of all buildings endangering the public safety.

A Flood from a 7-In. Rainfall at Kansas City†

A local rainfall of 7 in. in 10 hours on Sept. 8 caused heavy damage at Kansas City, Mo. The storm sewers were entirely inadequate to handle the rainfall and many basements were flooded. Far greater damage, however, was done in Rosedale, Kan., and Armourdale, Mo., which were inundated by the rise in Turkey Creek. The damage is estimated at $1,500,000.

The drainage area of upper Turkey Creek comprises about 14,000 acres; lower Turkey Creek has a drainage area of 1088 acres. The discharge of Turkey Creek at flood stage is about 28,000 sec.ft. It is practically the only outlet for the district and overflows at a low stage

*Notes from a recent bulletin of the National Fire Protection Association, 87 Milk St., Boston, Mass., by Franklin H. Wentworth. The bulletin may be purchased from the Association for 10c. per copy.

†Information furnished by Murray & Hamilton, Consulting Engineers, 920 Walnut St., Kansas City, Mo.

because the channel is small and crooked and has been further restricted by the construction of overhanging buildings resting on piles, and by the erection of numerous low, narrow railway bridges. Probably four-fifths of its drainage area is steep rocky hillsides.

Some of the bridges crossing the creek are of steel and some of reinforced concrete; but many are timber trestles, with bents spaced 16 ft. c. to c., which prevents the passage of any driftwood coming down the creek at flood stage. Most of the buildings which encroach upon the creek channel were carried away by the first rush of water or collapsed when their supports were washed out, adding to the wreckage in the channel and tending to dam it. Lumber from a lumber yard and wood poles from a supply yard of the Kansas Home Telephone Co. were added to the wreckage in the creek.

At the Terminal yards, just east of the Kaw River, the miscellaneous drift piled up against the bridges crossing the stream at that point, carrying away some and shifting others out of alignment.

The wide timber trestle at the mouth of Turkey Creek, which carried the Santa Fé feed tracks to the stock yards, was wrecked, leaving only a couple of tracks spanning a gap approximately 150 ft. wide.

Neither the machinery nor the settling basin of the pumping station, which lies in a bend of Turkey Creek and back about 1000 ft. from the Kaw River, was damaged.

The levees also were damaged. The first break occurred about 400 ft. upstream from the Kansas Belt bridge, and was 110 ft. across and about 35 ft. deep, extending into the Santa Fé yards approximately 200 ft. This break occurred where the Santa Fé had placed a 3-ft. storm sewer through the levee, and had evidently not tamped the ball fill properly. Several strings of box cars standing on the track at this hole were washed downstream.

A hole, about 60 ft. wide and 30 ft. deep, was washed in each side of an abutment of the Belt bridge, which is 2½ ft. lower than the levee grade. About 200 ft. downstream from the bridge another break occurred, where a 12-in. sewer extended through the levee. The hole washed here was about 200 ft. wide and 35 ft. deep. Several cattle cars were washed away and the cattle drowned.

F. H. McNeil, Chief Engineer of the Kaw Valley Drainage District, estimates that more than 35,000 cu.yd. of earth will be required to repair the damaged levee, exclusive of the filling required for the holes back of the levee. The levee was not designed to withstand any wash from the rear.

The Kaw River rose more than 10 ft., and had an estimated velocity of 7 ft. per sec. All railways from the southwest entering Kansas City were tied up, except the Chicago, Milwaukee & St. Paul Ry., and the Strang Electric line. The Chicago, Burlington & Quincy R.R., and the Atchison, Topeka & Santa Fé Ry., both had several miles of track washed out above Kansas City.

Turkey Creek has long been subject to destructive floods. There are three solutions to the problem: (1) Straightening the channel and diking along the creek; (2) constructing a reservoir for the excess water; (3) relieving the creek by a cut-off at the lower end of the upper district, through Gladstone Heights, and extending C. K. Creek sewer to the Kaw River, and draining the lower Turkey Creek basin into this sewer by means of a large storm sewer.

The crookedness of the present channel, the value of the adjoining land, the necessity of raising the Terminal yard through which the creek flows, and the lack of a site for a reservoir, make the first two solutions impracticable. The third was suggested by L. R. Ash, a former City Engineer of Kansas City, who recommended the diverting of a part of Turkey Creek through a tunnel which emptied into the Kaw River, approximately 100 ft. south, or upstream from the Fifth St. Bridge. Thi distance from the mouth of the natural course of the creek, measured up the river, is 6200 ft.; measured down along the natural course of Turkey Creek, it is 10,000 ft.

NEWS NOTES

Washouts at Eagle, Stoughton, Hanover, Broadhead and Gratiot, Wis., from heavy rains on Sept. 14 interrupted traffic on the Chicago, Milwaukee & St. Paul R.R.

A Scaffolding Collapse in the Cross Keys Moving Picture Theatre, under construction in Philadelphia, Penn., on Sept. 9, injured five workmen, who fell to the basement, 60 ft. below.

Lightning Struck Steel Oil Tanks near Ringling, Okla., recently. The subsequent fire destroyed 20 tanks, of which seven were of 55,000-bbl. capacity. About 600,000 bbl. of crude oil were stored in the tanks, accumulated in great part since the European war.

A Water-Supply Conduit Failed in a Los Angeles water tunnel near Hollywood, Calif., on Sept. 8, killing one workman and injuring another. The accident occurred on the line between the San Fernando Valley at the lower end of the Los Angeles Aqueduct, and Hollywood, where the water-supply enters Los Angeles.

Broken Axle Caused Collapse of a Steel Railway Bridge—A train of six cars, traveling at high speed, was derailed by the breaking of an axle, at a steel bridge over Crum Creek, west of Woodlyn, Penn., on the Baltimore & Ohio R.R. on Sept. 21. The train plunged through the bridge. One passenger was seriously injured.

The Collapse of a Concrete Span of the Twelfth St. Viaduct being constructed over Mill Creek Valley, St. Louis, Mo., on Sept. 18, injured the superintendent of construction, two civil engineers and two concrete workers. It is stated that the forms were being removed when the accident occurred. The collapsed section was 50 ft. long and it fell 50 ft.

A Freight Train Smashed a Street Car at a grade crossing five miles from Memphis, Tenn., on Sept. 17, killing nine persons and injuring 15 others. Just preceding the accident, a freight train had cleared the street-railway tracks and the crew of the car failed to observe that another train was following. The street car struck was being drawn by another car which escaped damage.

Air-Brake Trouble on a Train in the Phœnixville Tunnel of the Philadelphia & Reading Ry., near Philadelphia, on Sept. 21, stalled the train and filled the tunnel with gas and smoke. The engineman and conductor of the Pottsville express were killed and 20 passengers were overcome by the gas. The train had been stopped about 100 yd. inside the tunnel, on account of striking a workman on the tracks near the portal.

Collision with a Carload of Slag on a siding caused the death of ten persons and the injury of 30 others on a Queen & Crescent passenger train, near Livingston, Ala., on Sept. 18. The engineman, who was killed, is said to have received the clear signal at the block just preceding the Klondike switch where the wreck occurred. It is thought that the switch had been tampered with. The train, composed of six sleepers, two day coaches, mail, baggage and express cars, left Meridian shortly after midnight last night, a half-hour late.

Two Sections of a Large Water Main Broke, in Cincinnati, Ohio, on Sept. 14, badly damaging the pavement and cutting off the water-supply in its district for at least 12 hr., and flooding cellars and the Pennsylvania R.R. tracks in the vicinity. Superintendent Hiller stated that three or four days would be required to repair the damage. The situation was said to be further complicated by the fact that only one

f the reservoirs in Eden Park was available. Three reserve pumps were started almost as soon as the accident occurred and were of great assistance.

A Washout Caused a Severe Train Wreck on the St. Louis & San Francisco R.R., 2 miles west of Lebanon, Mo., on Sept. 15; 21 persons were killed and 18 injured. Heavy rains of the preceding week had swollen the streams in this vicinity to flood stages. In the heavy rain of the night before the accident, a 12-ft. fill crossing a gulley, on a curve, was washed out. Although it is stated that the train was not moving rapidly, it could not be stopped in time to save the locomotive, chair car and smoker from going over the structure. The four sleeping cars remained on the track.

Steamship Damaged by Fire While at Dock—A fire was discovered in the forward part of the Mallory steamship "Neuces," at 8 p.m., Sept. 18, at Pier 9 of the Tietjen and Lang Dry Dock Co., Hoboken, N. J. Considerable wood was used in some reconstruction work involving the addition of a number of staterooms and it was this woodwork which burned fiercely. There had been no fire in the ship engine room for several days, and it is believed that the blaze started in the reconstructed section. Tugs towed adjacent ships beyond the danger zone. Water was poured into the ship until she settled several feet. The fire, however, was gotten under control. The "Neuces" was built in 1887.

A Ship Collision on the St. Lawrence River caused the loss of 14 persons on the Government steamer "Montmagny," which was rammed by the Black Diamond collier "Lingan," at 5 a.m., Sept. 18, in a fog at the Beaujeu Banks, 1 mi. below Crane Island, and 26 mi. from Quebec. The "Montmagny" sank in 3 min. The "Lingan" backed off leaking badly. She is of the same type as the "Storstad," which sank the "Empress of Ireland" in the St. Lawrence last spring. She is of 4338 tons burden and was laden for Montreal. The sunken vessel is a steel, twin-screw steamer of 1269 registered tonnage, owned by the Canadian Government and employed by the Department of Marine and Fisheries. She was built in 1909.

A Heavy Explosion in a 6-ft. Brick Sewer, on East 42d St., New York City, at 5:30 p.m., Sept. 22, blew off some 30 manhole covers, injuring five persons and causing damage to several buildings by breaking windows. The heaviest explosion appeared to be in the vicinity of Third Ave., where three manhole frames and several square feet of the surrounding pavement were demolished. A trolley car standing near one of these manholes was badly splintered and three or four passengers injured. The manhole frames in at least two instances were entirely wrecked, and sections of asphalt pavement several feet square were thrown a number of feet away. The manholes are between the trolley tracks and next to the rails granite blocks were laid; these were thrown considerable distance and broke windows in nearby buildings. Flames followed the explosion, showing considerable quantities of gas. The sewer at this point is a brick-lined rock tunnel and to this fact is attributed the little apparent damage to the street. The bricklined manholes appeared badly cracked but at this writing an examination of the interior of the sewer had not been made. There were heavy explosions in this same sewer last July and again in August.

Divers Working on the "Empress of Ireland," in the St. Lawrence River, have recovered all the silver bullion and mails on the vessel. The mail sacks were sent to the Post Office Department, Ottawa. Diving work on this job has closed for the season.

The Pratt Bequest to the Massachusetts Institute of Technology, providing $750,000 for a school of naval architecture, practically has been allowed by the Massachusetts Supreme Court in indicating the way to be followed out of the technicalities upon which attempts to break the will were based.

The Three-Cent Fare Ordinance imposed by the city of Toledo on the Toledo Street-railway system (and resulting in a controversy noted in "Engineering News," April 16, 1914, p. 868) was declared confiscatory and unconstitutional on Sept. 12, by Judge J. M. Killits in the U. S. Circuit Court. The city's expert accountants are reported to have admitted reduction of earnings below reasonable return. Pending negotiations the 3c. rate will prevail during "workingmen's" hours, according to an earlier agreement.

The Substitute River and Harbor Appropriation Bill, passed by the Senate on Sept. 22, provides a lump sum of $20,000,000 "to be expended under the direction of the Secretary of War and the supervision of the Chief of Engineers for the preservation and maintenance of existing river and harbor works and for the prosecution of such projects heretofore authorized as may be most desirable in the interests of commerce and navigation and most economical and advantageous in the execution of the work."

The allotments to various works from the appropriations are to be made by the Secretary of War under direction of the Chief of Engineers and the amount allotted to work on the Mississippi below Cairo is to be expended under direction of the Mississippi River Commission.

Statistics of Accidents to Workmen in Ohio are made public by the Ohio Industrial Commission, reporting on the accident claims filed under the State Workmen's Compensation Act for the period from Mar. 1, 1912, to Dec. 31, 1913. Referring to the number of employees covered by state insurance, 110,000 in number, the report states that during the year 1913, 13 industrial accidents occurred for every 100 employees exposed to risk, or one employee was injured for every eight exposed to risk. Of course, most of these were minor injuries, for which medical and hospital expenses are paid, but no compensation is allowed unless a loss of time of more than seven days occurs. During the year, four employees out of every 100 insured received compensation for loss of time on account of accidents, or one in every 25 exposed to risk.

During the year, 16,544 accident claims were filed, of which 13,408 were allowed and 938 were disallowed, while 2198 were pending at the close of the year. Of the claims allowed, 40 were death claims, 2 were for permanent total disability, 302 were for permanent partial disability, 4787 were for temporary disability involving loss of time of more than seven days; 8277, or nearly two-thirds of the whole number, involved loss of time of less than seven days, and only medical and hospital expenses, not to exceed $200, were allowed. The total compensation allowed amounted to $378,000, of which nearly $100,000 was for death benefits. The average death benefit awarded was $2510.

The Negative-Head Mechanical Water-Filter Patent Decision against Harrisburg, Penn., noted on p. 528 of our issue of Sept. 11, 1913, has been reversed by the United States Circuit Court of Appeals of the Third Circuit. The court declares that Harrisburg has not infringed either of the two patents involved: No. 644,137, dated Feb. 27, 1900, and Reissue No. 11,672, dated Jan. 28, 1898 (original No. 546,738, dated Sept. 24, 1895.) In its summing up the court said:

> However, it is probably enough to say that (at the best) the evidence in behalf of the company leaves us in much uncertainty whether the theories of the patents are sound. We do not feel bound to go the length of declaring the patents invalid—the re-issue patent, indeed, has already expired, leaving the patentee only a claim for royalties—but we are prepared to say that while the subject is so surrounded by uncertainty the company cannot reasonably object to the application of a test that tries the Harrisburg filters by the theories of the patents.

The suit was originally brought in 1908 by the New York Continental Jewell Filtration Co., 15 Broad St., New York City. There appeared as expert engineers in behalf of Harrisburg, James H. Fuertes, Geo. W. Fuller and Allen Hazen, of New York City, and in behalf of the plaintiff filter company Geo. A. Johnson, of New York City, and Profs. Wm. P. Mason and James M. Caird, of Troy, N. Y. Various filter-manufacturing companies (licensees of the plaintiff) assisted in the suit against Harrisburg and that city was aided by a number of water-works having mechanical filter plants, as stated in more detail in our issue of Sept. 11, 1913.

PERSONALS

Mr. W. D. Jones, formerly of Pittsburgh, Penn., is now Designer for the Broken Hill Proprietary Co.'s steel works at Newcastle, Australia.

Mr. Satoru Nishioeda, Chief Engineer of the municipal water-works of Tokio, Japan, is visiting in this country for the purpose of inspecting and studying water-filtration plants. Last week he was in Philadelphia.

Mr. Fred W. Johnson has been appointed Engineer of the Springfield (Mo.) Special Road District. All the work in the district is to be done by county labor under the supervision of the three Commissioners of the district.

Mr. Alex. E. Kastl, M. Am. Soc. C. E., Consulting Engineer, formerly Special Deputy State Engineer, New York State Barge Canal, Albany, N. Y., has moved to Nolan, Mora County, N. M., in connection with the development of land in that vicinity.

Mr. W. F. Monfort has resigned as Chemist of the supply and purification division of the St. Louis, Mo., water-works. In order to devote his whole time to private practice as Consulting Chemist and Bacteriologist, with offices at 706 North Van Zenter Ave., St. Louis.

Mr. C. E. Knickerbocker, M. Am. Soc. C. E., former Chief Engineer of the New York, Ontario & Western Ry. and re-

cently Chief Engineer of the MacDonald Construction Co., New York City, has been appointed Cost Engineer, Division of Valuation, Interstate Commerce Commission, Washington, D. C.

Mr. David Van Alstyne has been appointed Assistant to the Vice-President of Operation of the New York, New Haven & Hartford R.R., with headquarters in New York City. Mr. Van Alstyne will be in charge of the test and store departments and of the handling of scrap, and he will have supervisory authority over the mechanical department in regard to organization, shop practice, approval of design, standards and requisitions.

Mr. Robert E. Kremers, Consulting Engineer, of Portland, Ore., has been appointed Chief of Highways and Bridges of the city of Portland, Ore., under Mr. Philip H. Dater, Assoc. M. Am. Soc. C. E., City Engineer. Mr. Kremers is a graduate of the civil engineering department of the University of Michigan, class of 1900, and for several years was Engineer of Bridges and Buildings of the Oregon Short Line R.R. at Salt Lake City, Utah.

Mr. J. H. Sanford, formerly Purchasing Agent of the New York, New Haven & Hartford R.R., has been appointed Purchasing Agent of the Connecticut Co., the Housatonic Power Co., the Berkshire Street Railway Co., the New York & Stamford Street Railroad Co. and the Westport Water Co. Mr. H. A. Fabian, Director of Purchases of the New York, New Haven & Hartford R.R. will have sole charge of that company's purchases. The appointment of an independent purchasing agent for the trolley companies is officially stated to be the last step in giving those companies a complete organization of their own, entirely independent of the management of the New York, New Haven & Hartford R.R. Mr. Sanford will make his headquarters in New Haven, Conn.

OBITUARY

J. A. McCague, Assistant Engineer, of Joseph T. Ryerson & Son, Chicago, Ill., was drowned while bathing on Aug. 16.

Prof. Charles Laden Adams, of the department of drawing of the Massachusetts Institute of Technology, died Sept. 17, at Antwerp, Belgium.

Henry Bratnober, a mining engineer, who prospected in many countries for the Rothschilds and Guggenheims, died Sept. 14, at his home in California.

Samuel McMurtie, a railway civil engineer of Denver, Colo., died Sept. 16, aged 57 years. He was born in Summit Hill, Penn., and was educated at Lehigh University. He was at various times a member of the engineering staff of the Denver & Rio Grande R.R., the Colorado Midland Ry. and the Southern Pacific Ry.

Edward Julius Hall, Assoc. Am. Inst. E. E., Vice-President of the American Telephone & Telegraph Co., died at Watkins, N. Y., Sept. 18. He was born at Perth Amboy, N. J., in October, 1853. Later his parents moved to Buffalo, N. Y., where he was educated in the public schools and at Sheffield Scientific School, Yale University, where he was graduated in 1873. He was identified with the telephone industry almost from the beginning and was the organizer of the local operating company in Buffalo, holding the offices of Vice-President and Manager. When the Buffalo company was taken over by the American Telephone & Telegraph Co. Mr. Hall became Manager of Traffic of the whole organization and devoted a large portion of his energies to the development of the long distance telephone business.

ENGINEERING SOCIETIES

COMING MEETINGS

INTERNATIONAL IRRIGATION CONGRESS.
Oct. 5-9. At Calgary, Alta. Secy., Andrew Miller, Industrial Commissioner, Calgary.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 12-16. Annual convention at Atlantic City, N. J. Secy., E. B. Burritt, 29 West 39th St., New York City.

NATIONAL COUNCIL FOR INDUSTRIAL SAFETY.
Oct. 13-15. Annual "Safety Congress," at Chicago, Ill. Secy., W. H. Cameron, Continental Bank Building, Chicago.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 20-22. Convention at Los Angeles, Calif. Secy., C. A. Lichty, 319 North Waller Ave., Chicago, Ill.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS
Oct. 20-23. Annual convention at New Orleans. Secy., James McFall, Roanoke, Va.

AMERICAN GAS INSTITUTE.
Oct. 20-23. Annual meeting in New York. Secy., George G. Ramdell, 29 W. 39th St., New York City.

AMERICAN ROAD CONGRESS.
Nov. 9-14. Atlanta, Ga. Permanent headquarters, American Highway Association, Colorado Building, Washington, D. C.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 6-9. Annual meeting at Boston, Mass. Secy., Charles Carroll Brown, Indianapolis, Ind.

NATIONAL MUNICIPAL LEAGUE.
Nov. 17-21. Annual meeting at Baltimore, Md. Secy., Clinton Rogers Woodruff, North American Building, Philadelphia, Penn.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Nov. 30-Dec. 5. Annual meeting at Jacksonville, Fla. Secy., Prof. Selskar M. Gunn, Massachusetts Institute of Technology, Boston, Mass.

Northwestern Road Congress—The states participating in the 1914 Congress to be held in Milwaukee, Wis., Oct. 28-31, are Wisconsin, Illinois, Michigan, Iowa, Minnesota, North Dakota and South Dakota. A brief review of the status of the highway problem in each state represented will be presented by the highway commissioner of that state. Among the subjects for discussion are the following: "What Responsibilities Should be Placed on the County Engineer or Commissioner?" "What Should be the Salary and Tenure of Office of the County Engineer?" "When Should Highway Work be Let by Contract and When be Done by Day Labor?" "What is the Best System of Inspection for Contract Road and Pavement Construction?" One of the sessions will be devoted to the characteristics of types of roads, and here brick, concrete, bituminous, gravel and macadam roads will be discussed. At another session, the relation of good roads to the health and prosperity of a community will be considered. Further information may be obtained at 71 Sentinel Bldg., Milwaukee, Wis.

American Society of Municipal Improvements—The 21st annual convention of the Society will be held at the Hotel Somerset, Boston, Mass., Oct. 6-9. On the opening day, the Committee on Standard Specifications will meet with the various subcommittees, wood-block, brick, bituminous, asphalt, concrete, stone-block, broken-stone and gravel roads, and sewers. Among the papers to be read are the following:

"The High-Temperature Incinerating Plant at Savannah, Ga.," E. R. Conant, Chief Engineer, Savannah, Ga.; "Sewage Disposal, Preliminary Investigations Required," E. A. Fisher, Rochester, N. Y.; "Converting an Old Septic Tank Into a Modern Two-Story Tank," Alexander Potter, New York City; "Economics of Sewage Filters," George W. Fuller, New York City; "Experimental Sewage-Disposal Plant of Brooklyn," George T. Hammond, Engineer-in-Charge; "Permanent Sediment Records of Water and Sewage," George C. Whipple, New York City; "Limitations of Water Filters," George W. Fuller; "Street Paving and Repairs," J. H. Sullivan, Boston, Mass.; "Sidewalks and Curbs," Harry S. Harris, Trenton, N. J.; "Sewer Construction and Maintenance," E. S. Rankin, Newark, N. J.; "Bleeding and Swelling and Longleaf Pine Paving Blocks," C. H. Teesdale, Madison, Wis.; "The Effect of Leaking Illuminating Gas on Bituminous Pavements," George C. Warren, Boston, Mass.; "Concrete Highways," George W. Meyers, Columbus, Ohio; "Napped, Reclipped and Grouted Granite-Block Pavements," William A. Howell, Newark, N. J.

The Secretary is Charles Carroll Brown, 702 Wilson Bldg., Indianapolis, Ind.

Western Society of Engineers—The first meeting of the season was held at the Society's rooms, in Chicago, Sept. 14, with President E. H. Lee (C. & W. I. R.R.) in the chair. A paper on "Permeability Tests on Gravel Concrete" was presented by Morton O. Withey (University of Wisconsin). The use of rich mixtures and fine cement gave best results, and a very wet consistency increases the rate of leaking in a lean mixture. The proportioning and curing are important; and a 1 : 1½ : 3 mix is very impervious. By grading the sand and gravel in accordance with Fuller's curve, it was possible to obtain watertight concrete of 1 : 9 proportions under pressures up to 40 lb. The tests related to gravel concrete, and did not cover the use of waterproofing compounds. In the discussion, E. B. Wilson (American Bureau of Inspection) mentioned tests of waterproofing floor slabs, in which the best results were obtained without such compounds.

A paper on "Reactions in a Three-Leg Stiff Frame with Hinged Column Bases" was presented by N. H. Stineman (C., M. & St. P. Ry.). It included special formulas, the special application of which is in the design of reinforced-concrete frames of the type mentioned, such as bridge abutments which are now being built by some railways. The paper was of a mathematical character.